Washington State

Hazard Mitigation Strategy

January 2000

Washington State Military Department
Emergency Management Division
Camp Murray, WA 98430-5122

First edition published 2000

Cover pictures from left to right:
1. 1998 Floods in Ferry County - Photo by Washington State Department of Transportation.
2. Landslide across SR 20 - 1998 - Photo by Washington State Department of Transportation.
3. Mt. St. Helens Eruption - May 19, 1982, Photo by Lyn Topinka
4. Kelso Landslide - Photo by Washington State Emergency Management.

FROM THE DIRECTOR

In recent years, Washingtonians have become increasingly more familiar with the effects of natural disasters. At times, it seems as though the frequency of presidential disaster declarations is increasing, and with it the enormous cost of recovery and reconstruction.

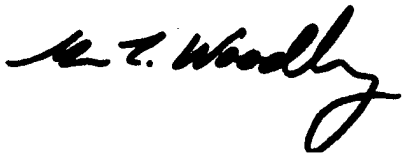
Our population is growing rapidly and development continues at a record rate. With each year, we have more and more people and property exposed and vulnerable to a variety of hazards. We cannot afford the continued high cost of disaster. We cannot afford the economic costs to the taxpayer, nor can we bear the social costs inflicted on our communities. We must break the wasteful cycle of disaster – recovery – reconstruction.

Driven by "The Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988," and with the assistance of the Federal Emergency Management Agency, Washington State Emergency Management is embarking on a full-scale effort to help make our communities safer by applying mitigation before disaster strikes.

The *Washington State Hazard Mitigation Strategy* is the state mitigation plan. In spite of the challenges, we intend to pursue every means to carry out the recommendations made by the state mitigation team. Recommendations we know will make Washington State a safer community.

In a December 6, 1995 address, President Clinton stated that, "Mitigation is about lowering the risk and reducing the effects of disasters, and this ambitious venture has the potential to reap great rewards. To successfully mitigate against disaster will require the combined talents and concerted efforts of all levels of governments, academia, professional and voluntary organizations, the corporate sector, and all Americans."

I wholeheartedly support President Clinton's comments. I too believe it will take everyone working together to make mitigation work. I encourage each community and state agency to develop a mitigation strategy and join the growing effort to make Washington a "Disaster Resistant" state. We stand ready to assist others in developing mitigation plans and invite you to participate with us as we refine our *Hazard Mitigation Strategy*.



Glen L. Woodbury
Director
Washington State Military Department,
Emergency Management Division

PREFACE AND ACKNOWLEDGEMENTS

This strategy is the culmination of more than two years work by many dedicated individuals. Much of the substance of this plan came about through countless meetings and correspondence of the Hazard Mitigation Survey Team, as well as the state sponsored all hazard mitigation strategies and planning meetings. We extend our grateful appreciation to:

State Agencies: Washington State Departments of Agriculture; Community, Trade and Economic Development, Ecology, Employment Security, Financial Management, Fish and Wildlife, General Administration, Health, Information Services, Labor and Industries, Social and Health Services; State Patrol, Natural Resources, Transportation; Governor's Executive Policy Office; Eastern Washington University-Urban and Regional Planning; Insurance Commissioner's Office; Office of Marine Safety; Military; Parks and Recreation Commission; Puget Sound Water Quality Action Team; Superintendent of Public Instruction; University of Washington; and Utilities and Transportation Commission. In addition, representatives for Senators Bill Finkbeiner, Rosa Franklin, Patricia Hale, Mary Margaret Haugen, Jeannette Wood, Joseph Zarelli, and Representative Patty Butler.

Local Organizations: Association of Washington Cities, City Engineers' Association, Association of County Engineers, Association of County Public Works, County Road Administration Board, Washington State Association of Counties, Washington State Association of County and Regional Planning Directors, Washington State Emergency Management Association, Washington Association of Building Officials, Structural Engineers Association of Washington, American Society of Civil Engineers, Elwha S'Klallam Tribe, Hoh Tribe, Spokane Tribe of Indians, Yakama Indian Nation, Cusick School District #59, Pierce County River Improvement District, and Cascadia Region Earthquake Workgroup.

Federal Agencies: U. S. Department of Agriculture-Natural Resources Conservation Service, Farm Service Agency, and Rural Development; U. S. Army Corps of Engineers; U.S. Environmental Protection Agency; Federal Emergency Management Agency; U.S. Fish and Wildlife Service; U.S. Geological Survey (Water Resources and Cascades Volcano Observatory); U.S. Forest Service-Olympic National Forest; Federal Highway Administration; Bureau of Indian Affairs; National Weather Service; Bureau of Reclamation; and Small Business Administration.

Private or Nonprofit Agencies: Inland Power and Light Company, Peninsula Light Company, Tacoma Public Utilities, Public Utility District of Pend Oreille, Grays Harbor Public Utility District, and Midway Sewer District.

Special thanks to the 1996-97 winter storms Hazard Mitigation Survey Team Leaders: Raj Joshi, Jean Chaney (landslides), Joy Shrilla (snowloading), George Currin and Rob Johnson (groundwater flooding), Bob Cornish (wind), Herman Huggins (ice), Christine Jonientz-Trisler (earthquake) all with the Federal Emergency Management Agency, Region X; Tim D'Acci, Dan Sokol, and Dave Burdick (Department of Ecology, rivers and streams), and Hugh Shipman (Department of Ecology, landslides).

Special thanks also goes to Joan Sterling of the Washington Military Department, Emergency Management Division for the countless hours of research, team building and documentation that provided the basis for this document.

EXECUTIVE SUMMARY

Mandated by the Robert T. Stafford Act of 1988 (Stafford Act), Washington State Emergency Management began the process of developing this mitigation strategy in 1997. The Stafford Act (44 CFR 206.405) requires the development of a mitigation plan within 180-days following a presidential disaster declaration. The intent of the Stafford act is to apply mitigation in the rebuilding process so that future losses from a disaster can be eliminated or reduced.

Waiting for disaster to strike before beginning mitigation planning, complicates and slows the recovery process. That is why there is an emphasis on mitigation planning before disaster strikes. By planning ahead, mitigation projects can be coordinated well in advance, priorities set, funding sources lined up and projects started before disaster strikes or immediately after without the intense efforts of doing the same thing within 180-days of the declaration, as is required by the Stafford Act.

This, the *Washington State Hazard Mitigation Strategy* is the plan required by the Stafford Act. It identifies the major issues surrounding numerous hazards and lists a number of mitigation recommendations to allay the effects of future disaster.

This summary outlines the 13 major mitigation issues identified by the original mitigation team, and presented in this document. Each issue addresses a broad area and in most cases has numerous recommendations. Recommendations are categorized as 'high,' 'medium,' and 'low' priority. For the purpose of brevity, only the 'high' priority recommendations are included in this summary. Some recommendations have been abbreviated for the same reason. For specifics on issues of interest, please refer to the appropriate section of the strategy.

Mitigation plans and strategies for many hazards are covered in other publications. For example, earthquake mitigation is covered in "A Policy Plan for Improving Earthquake Safety in Washington: Fulfilling Our Responsibility" (Department of Community Development, 1991). Consequently, you will notice that many obvious hazards and applicable mitigation strategies are missing from this publication, but because they exist elsewhere, they are not included in the *Washington State Hazard Mitigation Strategy*. For a list of other mitigation publications or statutes containing mitigation plans, strategies, or recommendations, see Appendix D.

Following are the 13 mitigation issues and priority recommendations presented in this document:

Issue 1 – Geotechnical reports lack consistency and have a tendency to be narrow in scope. Reports are often rendered by engineering geologists or geotechnical engineers, whose qualifications have not been established by the state through licensing or certification. In addition, most local jurisdictions lack the qualified staff or expertise to determine the quality of a completed report.

Recommendation 1-1
Require certification or licensing for professionals performing geotechnical evaluations and recommendations… If certification or licensing through the state is not feasible, develop minimum standards and qualifications through the professional engineering organizations…Qualification guidelines should define the roles of each engineering category, required professional

certification (if applicable), level of experience, and the minimum criteria for licensing or certification.

Issue 2 – Existing maps and information are inadequate for planning and decision making.

Recommendation 2-1
Prepare comprehensive maps of landslide susceptible areas… Mapping should focus on areas of rapid growth: tie them into the growth management planning when available and use this information as a guideline for rural areas.

Recommendation 2-2
Enhance flood maps to reflect actual flow rates, using cubic foot per second contours. Maps should incorporate riverine, stream, and significant groundwater events. A flow map would be easy to maintain. You can use the map to compare rates of discharge, and make amendments as needed.

Recommendation 2-3
Encourage flood map updates that include fully developed areas and/or the built-out environment. Consider historical weather data as well as building and land for its cumulative effect on the environment. This is especially necessary when calculating flood frequency and development policy within urban watersheds.

Issue 3 – Flooding continues to be the most frequent cause of disaster in the state. Development, combined with clear cutting and other land management practices continue to exacerbate the threat of flood hazards to people and property and contributes to erosion throughout the state.

Recommendation 3-1
Simplify and shorten the permitting process for flood damage reduction and stream improvement projects.

Recommendation 3-2
Develop a technical information manual on bank protection options that encourages enhancing habitat values for use by private property owners.

Issue 4 – Landslide hazards are becoming more prevalent and constitute a significant risk to people, property, and the infrastructure. The identification of landslide prone areas, development of effective mitigation strategies, land use management, and sufficient numbers of knowledgeable and qualified (certified) professionals capable of defining the threat need to be addressed.

Recommendation 4-1
Vegetation Management. Appropriate parties need to agree on vegetation management standards. This is also appropriate for wind, ice, flood, wildfire, and earthquake or other damages.

Recommendation 4-2
Review the State Forest Practices Act. The Forest Service Practices Board should be consulted regarding possible revisions to the State Forest Practices Act to lessen the risks to utility and transportation routes.

Issue 5 – Transportation is essential to Washington's vitality. The risk to local bridges, marine and port facilities, highways, transit systems, airports, and rail facilities from earthquakes, flooding and landslides must be determined so that priority can be given to mitigating critical routes, staging areas and airport facilities.

Recommendation 5-1
Assess the disaster survivability of lifeline routes to include state and local roads, bridges, transit routes, railroad, and port facilities. Determine appropriate retrofits and prioritize emergency routes.

Issue 6 – Mitigation is key in reducing future damage from any number of hazards. However, there is currently little incentive for communities to plan for or initiate pre- and post-disaster mitigation projects.

Recommendation 6-1
Record high water marks immediately following a record flood, especially when there has been significant development or changes in the area. High water marks will help determine the need for flood map revision or the need to take other measures.

Issue 7 – While warning systems in the state have improved in recent years, there is still a need to educate the public on the terminology used and its meaning; improve river and stream flood gauges so that more accurate predictions of flooding can be made; and improve the reliability of warning equipment, especially tsunami warning systems for near shore earthquakes, and lahar warning systems for people in the inundation zones around the state's five volcanic peaks.

Recommendation 7-1
Determine current rain and stream gage capabilities of local, state, and federal agencies in flood-prone areas. Identify additional locations in river basins, urban streams, and watersheds, subject to frequent flooding, where gages are needed to improve forecast and warning capabilities. Identify funding source(s) for installation, monitoring, and maintenance.

Issue 8 – While there are a number of coordinated state level plans that deal with hazard mitigation, local plans and strategies are nearly nonexistent.

Recommendation 8-1
Develop local hazard reduction plans/strategies.

Recommendation 8-2
Develop and maintain a list of approved comprehensive flood management plans. Consider posting this list on the Internet.

Recommendation 8-3
Develop a training program for local jurisdiction officials that explains the value of mitigation planning and shows them how to implement the process.

Recommendation 8-4
Develop a mitigation campaign strategy aimed at raising the interest level of local government officials in the mitigation process.

Recommendation 8-5
Develop a hazard mitigation-planning workbook for use in developing local mitigation plans.

Issue 9 – Communication systems often lack redundancy and interagency/governmental operability preventing essential communication during and immediately following a disaster.

Recommendation 9-1
Schools should consider developing prepared messages for distribution to selected media in times of inclement weather and emergencies. Identify if alternative communications, such as radios are available. Make sure emergency plans and procedures are well known throughout the community.

Issue 10 – Critical facility identification and protection is lacking in many communities, as is the need to identify and protect essential lifelines.

Recommendation 10-1
Inventory school buildings as to their risk, by district. The inventory should include the building age, number of students housed, and other risk factors. This survey should address maintenance and repair requirements as well as training on seismic safety issues, accessibility, and liability.

Recommendation 10-2
Prolonged Power Outage. Develop an inventory of critical facilities that must have electrical power during power outages. The inventory should include electrical power generation requirements/capacity. It should also state whether the site is suitable for use as a shelter (kitchen, a serving area, rest rooms, and heated sleeping area(s).

Recommendation 10-3
Research current, statewide requirements and the possibility of legislation that would require back-up electrical power in emergency and critical facilities such as police, fire, school, water and waste water treatment facilities, and health care facilities. Most nursing homes have a limited back-up power supply.

Recommendation 10-4
Determine if the local Growth Management Act and site zoning take rights-of-way and corridors into consideration for development in areas containing natural gas pipelines.

Issue 11 – Additional attention needs to be given to where special needs individuals, especially those with serious medical problems, are housed, and how they cared for in times of disaster. Livestock, pets, and wildlife need to be protected and cared for as well.

Recommendation 11-1
Construct medical facilities in areas free from floods and lahars. Design facilities to meet building standards appropriate for local hazards. Design multiple access routes and plan evacuation scenarios.

Issue 12 – The enforcement of building codes and standards is negatively impacted by insufficient personnel resources and training.

Recommendation 12-1
Building departments should be more pro-active in citing builders/owners for building or modifying buildings without permits, or who fail to meet applicable building codes. Many structures that fail in windstorms or earthquakes are built without permits or proper engineering. Inadequate staffing of building departments and political pressures that contribute to non-enforcement must also be examined.

Recommendation 12-2
Conduct research on building failures to determine if the building design and construction met code requirements. Designers and architects need to be included since their seal is on the line.

Recommendation 12-3
To ensure public health, relocate or retrofit water systems and sewage treatment facilities so they are capable of functioning in any hazard.

Recommendation 12-4
Conduct research to determine if pre-engineered buildings should be designed to higher load capacity standards. Contact structural engineers who have been involved in the assessments of particular buildings.

Issue 13 – Public awareness of the state's many hazards, associated risks, and how to plan for or respond to such events is limited. As the population of the state grows, there is a continuing need for public education and awareness especially concerning earthquakes and tsunamis.

Recommendation 13-1
Prepare or adopt a technical manual that illustrates methods for identifying site-specific landslide hazard areas.

Table of Contents

INTRODUCTION

The state of Washington is one of the most beautiful places in the United States to live. However, one often forgets that most of Washington's beauty was created by violent acts of nature. The state's landscape was, and continues to be, sculptured by volcanic eruptions from numerous volcanoes, earthquakes from a myriad of faults, wind, rain, winter storms, and the incessant wave action that often erodes the coastal shoreline.

While Washington State's climate, topography, and geology provide its citizens with a beautiful environment and abundant natural resources, that same environment is the basis for frequent widespread natural hazard events which, over the years, have threatened or done extensive damage throughout the state.

Natural and technological hazards are many and varied in Washington State (See Washington State Hazard Identification Vulnerability Analysis). In and of themselves, these hazards present little dilemma. However, when people and property are added to the equation, there in lies the problem.

In 1996, Washington was rated the sixth fastest growing state in the nation, a trend that was expected to continue (Washington State Office of Financial Management, 1997). The state's population at the time of this publication stands near six million. According to the state Office of Financial Management, the population is projected to grow by 40.2 percent, from 5,429,900 in 1995, to about 7,610,100 in the year 2020. In addition, 16 percent or nearly 1.2 million of the population will be 65 or older compared to 11.6 percent in 1995. Clallam, Columbia, Garfield, Jefferson, Lincoln, Pacific, and San Juan Counties have the largest percentage of over 65 population as of 1997.

According to *1997 Population Trends* (Washington State Office of Financial Management, 1997), King, Kitsap, Pierce, and Snohomish Counties accounted for 70 percent of the statewide growth during the 1980's. These four counties still account for half of the current growth.

A strong migration of the population from 1990 through 1995 was to rural, less populated areas. Clark County was the fastest growing county for 1990-97. The next largest county population increases (over 20 percent) since 1995 occurred in Grant, Jefferson, Mason, and Pend Oreille. These counties offer some of the best opportunities for retirement living and recreation.

As the population and built environment of the state grows so does the risk to people, property, and the environment from all of the state's hazards.

State history tells a cyclical story of disaster after disaster, followed by an increasingly more costly recovery process. We can expect more natural and technological hazards in the future, but through effective mitigation, we can reduce the risk to people and property, and diminish the cost of future disasters.

PURPOSE, SCOPE AND AUTHORITY

Purpose. In response to the unacceptable loss of life and property from recent disasters, and the prospect of even greater loss in the future, the *Washington State Hazard Mitigation Strategy* provides a conceptual framework to reduce future losses. The strategy strives to engender a fundamental change in the perception about reducing hazard risk through mitigation and to demonstrate that mitigation is often the most cost-effective, and environmentally sound, approach to reducing losses. The overall long-term goal of the strategy is to substantially increase public awareness of natural hazard risk and to significantly reduce the risk of loss of life, injuries, economic costs, and the disruption of families and communities caused by hazards.

Scope. The *Washington State Hazard Mitigation Strategy* identifies hazard mitigation goals, objectives, issues and recommendations that are not already identified in other mitigation documents. The recommendations act as risk reduction strategies for the loss of life, injuries, economic costs, and the destruction of natural and cultural resources that result from natural or technological hazards.

Mitigation strategies in this document are complemented by a number of other federal and state publications that also address mitigation either directly or indirectly. A list containing some of these can be found at Appendix D.

Authority. The Washington State Hazard Mitigation Strategy was developed in compliance with the requirements of P.L. 93-288, the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended, Section 409.

Section 409 states in part:

> "As a further condition of any loan or grant made under the provisions of this Act, the State or local government shall agree that the natural hazards in the areas in which the proceeds of the grants or loans are to be used shall be evaluated and appropriate action shall be taken to mitigate such hazards, including safe land-use and construction practices, in accordance with standards prescribed or approved by the President after adequate consultation with the appropriate elected officials or general local governments, and the State shall furnish such evidence of compliance with this section as may be required by regulation."

44 CFR, Section 206, Subpart M states in part:

> "In order to fulfill the requirement to evaluate natural hazards within the designated area and to take appropriate action to mitigate such hazards the State shall prepare and implement a hazard mitigation plan or plan update."

The minimum requirements of this plan are spelled out in this section as well.

NOTE: Maintenance and use of this document are requisites for receiving federal disaster funds. Failure to pursue mitigation strategies may jeopardize future federal funding.

MITIGATION

Throughout the four phases of emergency management – preparedness, mitigation, response, and recovery – there is some logical overlapping of concepts. This is especially true between hazard mitigation and emergency preparedness. Hazard mitigation is the effort to reduce or lessen the effects of the hazard, while emergency preparedness may be the mechanism for accomplishing the effort. However, hazard mitigation is the only phase of emergency management that can break the cycle of damage, reconstruction, and repeated damage.

Mitigation is defined as a "sustained action that reduces or eliminates long-term risk to people and property from natural hazards and their effects." This definition distinguishes actions that have a long-term impact from those that are more closely associated with preparedness for, immediate response to, and short-term recovery from a specific event. The intent is to focus on actions that produce repetitive benefits over time, not on those actions that might be considered emergency planning or emergency services.

The purpose of mitigation is twofold:

1. To protect people and structures; and
2. To minimize the costs of disaster response and recovery.

Hazard identification and risk assessment is the cornerstone of mitigation. The *Washington State Hazard Identification Vulnerability Analysis* (HIVA) (2000) provides detailed information on the hazards, risks, and vulnerability to natural and technological hazards in Washington State. The development of the *Washington State Mitigation Strategy* is based on hazards listed in the HIVA.

Hazard mitigation can be accomplished in a number of ways and can generally be broken down into the following strategies:

1. Alter the hazard. The hazard can be altered to eliminate or reduce the frequency and intensity of it occurrence. For example, explosives are used to trigger avalanches in a controlled environment.

2. Avert the hazard. Redirecting the impacts away from a vulnerable location can avert the hazard. "Pubic works measures" usually refers to the most commonly known engineering measures used to contain or redirect natural hazards.

   Public works measures are of two types: structural and land treatment. Structural measures directly protect people and property. Some examples include dams, reservoirs, dikes, levees, seawalls, debris basins, and bulkheads. Land treatment attempts to reduce the intensity of hazard effects by modifying the natural environment. Land treatment measures might entail reforestation, contour plowing, grading, soil stabilization and vegetation management.

   Local, state and federal agencies have attempted to avert some flood hazards by constructing dams, levees, and dikes, which have met with limited success. Key limitations of these methods include the expense involved in construction and repair, and the uncertainty of the effectiveness.

   "In some cases the costs of these repairs do not seem justified by the benefits of the project. A series of levees on the Cedar River, for example, needed roughly $265,000 in repairs but protect only two homes worth a combined total of approximately $300,000. Over time, the cost of repairs could easily exceed the value of the protected property" (King County Surface Water Management, 1993, p. 18).

"… structural flood control, no matter how well designed and built always carries a risk of failure. Unfortunately, it also became clear that the presence of these projects creates a false sense of security among landowners, often encouraging development in hazardous areas because there is not sufficient understanding of the risk" (King County Surface Water Management, 1993, p. 15).

Structural efforts avert, but do not eliminate hazards. For example, flood structural measures protecting one area redirect flood hazards to other vulnerable areas, doing little to address the problem of flood hazards overall.

3. Adapt to the hazard. By adapting to the hazard, development or redevelopment is less vulnerable. For example, retrofitted masonry structures suffer less damage in earthquakes. Redevelopment involves rebuilding damaged structures so that vulnerability to future damage is minimized and economic viability is improved.

   It is not as important why something was damaged as much as to ensure that repairs are appropriate to prevent repetitive, future loss. For instance, it may be appropriate to replace wooden utility poles with concrete or aluminum poles or place utilities underground, or relocate the utility to another site to prevent windstorm damage.

   Efforts to adapt to hazards have been successful. For example, strategies to modify structures in floodplains, to prevent or reduce damages, work well because there is not a dependency upon redirecting large volumes of water. Instead, attempts are made to keep structures out of harm's way by elevating above the water.

4. Avoid the hazard. The hazard can be avoided by keeping people away. Local ordinances may regulate the location and manner is which new construction occurs in relation to existing hazards. Permanent evacuation of a hazardous location is the ultimate method for keeping people away from hazards. Acquisition and relocation are strategies often used in avoiding the hazard.

   The most successful means of mitigating flood damages has been the strategy of avoiding flood hazards. By discouraging development of vulnerable structures in floodplains, localities protect these structures and provide a place where floodwaters can collect. By providing a safe place where floodwaters can collect, localities provide a greater measure of security against flood hazards for structures outside the floodplain. Such measures involve considerably less expense than the cost of public works measures. By limiting development near floodplains to facilities with the least potential for damage, such as public parks, golf courses or other regulated uses, land us is maximized.

   For these reasons, the Federal Emergency Management Agency and the state of Washington encourage strategies that emphasize avoiding flood hazards. The National Flood Insurance Program Reform Act reinforces this paradigm. The Act calls for the relocation or modification of structures located in a floodplain, which are substantially damaged by a flood. The Act also provides financial assistance and encouragement to local and state governments attempting to mitigate flood hazards.

5. Acquisition. Acquisition is the public procurement and management of lands that are vulnerable to damage from hazards.

Following acquisition, land use more appropriate to the degree of risk may be chosen.

6. Relocation. Relocation involves permanent evacuation of hazard-prone areas through movement of existing hazard prone development and population to safer areas. Two common components of relocation are physical removal of buildings to a safer area with the future use of the vacated area limited to permanent open space, and substitution of existing uses for others that are less vulnerable to the hazard.

Whatever the strategy, mitigation measures must be evaluated in the context of myriad constraints: time, resources, geography, the level and nature of development and vulnerability, and the attitudes and desires of the affected communities and property owners, to name a few. Choices must be realistic and attainable when these constraints are taken into account. For example, flood mitigation measures, such as elevating manufactured homes on concrete blocks, might not be appropriate in areas prone to earthquakes, unless the home is made secure from earthquake damage at the same time. Risk reduction measures for natural disasters must be compatible with risk reduction measures for technological hazards and vice versa.

All mitigation is local. At all levels, governments and constituencies play critical roles in advancing mitigation by articulating the vision and developing the programs and incentives that encourage and support community-based implementation. They also advance the cause by adopting and holding themselves to the land use, construction, and enforcement standards they advocate for others. However, success or failure depends on decisions made by individuals. Mitigation takes place when a business or a homeowner decides to take action to reduce the risk of damage to the structure from wind, water, fire, or earthquake; a community develops a pre-disaster plan for undertaking a broad range of mitigation activities; a city council votes to upgrade the professional qualifications required or its building inspectors; a county removes flood prone land from development potential and creates a recreation area; a state legislature adopts a building code that is binding on all the political subdivisions.

There is an ongoing need to emphasize insurance as an effective and invaluable preparedness, recovery, and hazard mitigation tool. Better hazard education and comprehensive mapping may be the answer. One must fully understand the hazards, their vulnerability and risks associated with each hazard. Detailed mapping of earthquake faults and liquefaction zones, landslide areas, flood zones, lahar inundation areas, etc. must also be made available so that risk areas are well defined.

The Flood Insurance Rate maps, developed by the National Flood Insurance Program, can be a useful tools for determining the risk of being in the floodplain. Combined with efforts in the Growth Management Act for geologically sensitive areas, the vulnerability of a community can be identified and the effects lessened or prevented. Unfortunately, maps cannot predict the increased density of development and unknown hazards, such as debris back-up or groundwater saturation, which may cause more flooding. Mapping of a 100-year floodplain does not take into consideration development within the watershed.

There is a continual need to look at land use practices that add to impermeable surfaces such as developments near floodplains, or new construction altering storm flows. For hazard

mitigation to be effective, it is essential to look at all hazards, and plan for the whole area affected.

The Federal Emergency Management Agency (FEMA), Region X, is the state's partner for providing federal planning, training, and funding to support state and local jurisdictions' efforts. Additionally, FEMA is the main point of contact for the Washington Military Department, Emergency Management Division, for federal assistance and response activities when the capabilities of local and state government are exceeded.

In recent years, several Washington State communities have joined in a partnership with FEMA's Project Impact. Project Impact – Building A Disaster Resistant Community, is FEMA's way of changing how America deals with disaster. Project Impact helps communities focus their energy to protect themselves from the devastating effects of natural disasters by taking actions that dramatically reduces disruption and loss.

In October 1997, The City of Seattle was selected by FEMA as one of seven pilot communities. Armed with one-million dollars in seed money from FEMA, Seattle Emergency Management collaborated with Contingency Planners and Recovery Managers (CPRAM) to begin planning ways to best focus their program. Seattle's goal is to create projects that could be exported and expanded throughout the region. Seattle chose three project areas on which to focus – home retrofit, school retrofit, and hazard mapping.

King and Pierce Counties, home to 40% of the population, were each awarded $300,000 from Project Impact. In an act of true collaboration, they pooled their funds to do regional projects. They too chose to focus on three high priority projects areas – transportation corridor, small business disaster mitigation, and a two-county computer tie down campaign.

Walla Walla County, the state's 1999 Project Impact community, has formed a citizen advisory committee and has contracted for development of a comprehensive flood management plan to mitigate recurring flood problems in the county.

Kitsap County was awarded a Project Impact grant for federal fiscal year 2000. Their focus will be on developing the GIS.

"Disaster costs and the impacts of natural hazards can be reduced by emphasizing pro-active mitigation before emergency response; both pre-disaster (preventative) and post-disaster (corrective) mitigation is needed." (Basic Principles of the National Mitigation Strategy, June 99).

The Washington Military Department, Emergency Management Division Hazard Mitigation Strategic Plan – 1999 provides guidelines for a proactive mitigation strategy.

HAZARD MITIGATION STRATEGIC PLAN – 1999

The vision, goal, strategies, and objectives that follow are the cornerstone of this document.

Vision

Maximize the disaster resistance of Washington State citizens, communities, businesses, and governments through all-hazard mitigation.

Goal

To facilitate the identification, development, implementation and evaluation of hazard mitigation strategies and activities to reduce statewide vulnerability to the effects of natural and technological hazards.

Strategies

1. Focus state-sponsored hazard mitigation efforts through implementation of the *Hazard Mitigation Strategy*.

2. Assist state and local agencies develop and implement local hazard reduction plans.

3. Compile local hazard reduction plan information to avoid duplication of multiple program requirements.

4. Operate the Hazard Mitigation Grant Program in such a way as to exceed FEMA regulations and state guidelines.

5. Develop and maintain a long-range strategy for encouraging local mitigation efforts through the Hazard Mitigation Grant Program, the Mitigation Assistance Program, the Flood Mitigation Assistance Program, Project Impact, and the Growth Management Act.

6. Revitalize and update the Emergency Management Council's Seismic Safety Subcommittee Report on seismic threats to the state.

7. Initiate local and state planning efforts to improve tsunami warning and evacuation systems.

Objectives

1. Encourage inclusion of hazard mitigation as a fundamental part of state and local planning and budgeting.

2. Coordinate opportunities to promote and enhance hazard mitigation activities.

3. Identify and reduce potential impacts from seismic threat.

4. Identify and reduce potential impacts from repetitive flood damage.

Performance Measures

1. Develop, publish, distribute, and annually review the *Hazard Mitigation Strategy*.

2. Compile and annually review status of local hazard reduction plans (initial data to be established by September 30, 2000).

3. Close Hazard Mitigation Grant Program within four years of disaster declaration.

4. Reduce the number of repetitive loss structures within the funding capacity of the annual Flood Mitigation Assistance Program and the post-disaster Hazard Mitigation Grant Program.

5. Establish and maintain community-based cooperative organizations committed to hazard mitigation.

6. Develop and implement 30 percent of the recommended mitigation strategies from the Seismic Safety Subcommittee Report on seismic threats.

7. Install additional tsunami warning systems and integrate county systems by 9/30/1999.

HAZARD IDENTIFICATION VULNERABILITY ANALYSIS

Refer to separate document: State of *Washington Hazard Identification Vulnerability Analysis* (2000).

ISSUES AND RECOMMENDATIONS

Issue 1

Geotechnical reports lack consistency and have a tendency to be narrow in scope. Reports are often rendered by engineering geologists or geotechnical engineers, whose qualifications have not been established by the state through licensing or certification. In addition, most local jurisdictions lack the qualified staff or expertise to determine the quality of a completed report.

Discussion

Generally, when a proposal for development of an area vulnerable to landslides is submitted, a geotechnical report is prepared to analyze the risk to the site and impacts on the proposed or existing development. The main problems cited by local jurisdictions and state agencies regarding these reviews is an inconsistency in quality and scope of geotechnical reports due to the lack of required credentials for geotechnical professionals preparing these reports, including no standard scope of review or final product expectation. When local building officials require geotechnical reports, it is important that the report covers the actual needs for the potential building site. Local jurisdictions often are unable to perform technical review of the geotechnical reports due to the staff's lack of expertise or adequate funding of an expert review.

Finally, because they are often based on project financing rather than the severity of the hazard, the geotechnical report and the recommendations are usually too narrow in scope. Cost is directly proportional to the detail of the reports.

Registration for Geotechnical Professionals

Currently, there is no state requirement to register professionals, through certification or licensing, who may analyze landslide potential areas and recommend remedial measures to minimize damage. Normally, an engineering geologist or geotechnical engineer will perform this work. However, there is no requirement that professionals perform these reports. Engineering geologists and geotechnical engineers have distinct responsibilities. Geologists are responsible for mapping, and engineers are responsible for design. Considering that these professionals have specialized training and unique work experience, it is easy to understand how they can often generate differing or conflicting recommendations and reports.

One proposal to remedy this situation suggests developing standards or guidelines that can be used to assess the qualifications of an engineering geologist or geotechnical engineer to perform a landslide analysis. The standards or guidelines would be the foundation for licensing or certification.

Although certification or licensing will not solve the immediate problems of inadequate or inconsistent geotechnical reports, it will give local jurisdictions one method for judging the competence of individuals preparing quality, analytical reports.

Expertise for Review of Geotechnical Reports

Another issue voiced by local jurisdictions was a general lack of in-house expertise to review the quality of geotechnical reports. Typically, local jurisdiction personnel do not have the qualifications or expertise to judge the adequacy of reports. Only a few local jurisdictions in the state have engineering geologists or geotechnical engineers on staff.

In addition, there are no comprehensive review standards to aid local jurisdictions in gaining appropriate knowledge for review of these reports.

One method to provide such expertise is to have a state agency (as done in Colorado and Utah) or a peer review group of geotechnical engineers review reports submitted to the local jurisdictions. When Utah standards were established, the first reviews resulted in over 90 percent of the reports being rejected. As the standard became known, the rejection percentage decreased. This type of review could lessen the environment impact, provide liability protection, and benefit the property owner. Peer reviews have also been successful in Issaquah, WA. In Issaquah, a local review team consisting of volunteers meets regularly to review Environmental Impact Statements and geotechnical reports.

Another method of review could be developed by consolidating previous geotechnical reports, in Geographic Information System (GIS) format, allowing for comparisons of the same or adjacent properties within the jurisdiction. This would allow the geotechnical professional to review current information and focus the report accordingly. For the most part, jurisdictions discard reports upon approval of the associated project (U.S. Army Corps of Engineers, Seattle District, 1997).

Unlike streamflow and meteorological data, there is no comprehensive landslide database maintained by one agency in Washington. The data that is retained varies considerably among governmental agencies, including the time series and number of landslides, the severity, and magnitude. Over time, land use and population effects need to be part of any analysis.

Finally, development of a model geotechnical report checklist for jurisdictions to use in review of geotechnical reports would help in providing consistent reviews. Due to the complexity of geologic hazards, checklists should only be used as a guide and not an absolute requirement. Otherwise, costly studies might be required in areas where the information gained would be redundant or of little value. Components of a model checklist might include site data, analysis, interpretation, conclusions, and recommendations.

Resource Driven Reports

Many local jurisdictions report that the scope of geotechnical reports is often too narrow. The report may focus, for example, on the specific site conditions, rather than the geologic conditions that extend beyond the actual site. The basis of this narrow scope is often the result of limited financing by the property owner or project proponent. In the interest of saving money, individuals will opt for the least expensive engineering evaluation and recommendations. The drawback of such an approach is the failure to realize the extent of the risk for future landslides. Consistent requirements regarding the scope of such reports and the extent of possible mitigation would be beneficial in educating property owners to the risk they face when choosing mitigation measures. Recommendations should meet the intent of the law and codes, yet not be cause for over building for any environmental hazard. An option is to use a guideline for reports, such as those used in California that have been used successfully for decades.

Recommendations

High Priority Recommendations

Recommendation 1-1
Require certification or licensing for professionals performing geotechnical evaluations and recommendations. Previous efforts to require certification and establish minimum qualifications for engineering geologists and geotechnical engineers should be reevaluated for feasibility by the state, local jurisdictions, and geotechnically related

professional organizations. Further, the roles of geologists and geotechnical engineers should be defined and clarified through professional organizations. Certification of engineers may be beneficial in limiting liability and will improve the quality of reports.

If certification or licensing through the state is not feasible, develop minimum standards and qualifications through the professional engineering organizations. Through certification or licensing, local jurisdictions will have a way to verify an individual's qualifications.

Qualification guidelines should define the roles of each engineering category, required professional certification (if applicable), level of experience, and the minimum criteria for licensing or certification.

Recommended Lead Agency (ies): Departments of Natural Resources (DNR), Ecology (Ecology), and Licensing (DOL) with support by the Seattle American Society of Civil Engineers, and the Association of Engineering Geologist in coordination with local jurisdictions.

Medium Priority Recommendations

Recommendation 1-2
Establish a funded program for state agency or peer review of geotechnical and geologic reports. Options include:

1. Establish a clearinghouse run by a state review board for those local jurisdictions that voluntarily request aid in technical review.
2. Establish a "circuit rider" engineering geologist and geotechnical engineer positions in a state agency to aid local jurisdictions without geotechnical resources.
3. Establish a peer review board consisting of engineering geologists and geotechnical engineers through professional organizations.

Individuals reviewing the geotechnical or geologic reports should have considerable expertise and be able to provide the review service to local jurisdictions in a timely manner. Local jurisdictions have a 120-day review time, which sometimes restricts their options. Having an audit system in place, whether using expertise on staff or contracted services, will help ensure consistency, especially in areas of repetitive loss.

Recommended Lead Agency (ies): Washington State Departments of Natural Resources (DNR) and Ecology (Ecology). Prerogative of local jurisdictions with assistance from the Seattle Geotechnical Group, and the American Society of Civil Engineers (ASCE).

Low Priority Recommendations

Recommendation 1-3
Develop minimum state guidelines for assessing landslide hazard areas. A 9 May 1997 letter from the Department of Natural Resources indicated it would take an additional seven or eight staff years and approximately one million dollars to complete this recommendation and to establish a training team (Recommendation 4-6) to help local jurisdiction personnel understand and implement a landslide hazard identification technical manual.

Recommended Lead Agency (ies): DNR and Ecology with assistance by the Seattle American Society of Civil Engineers, Geotechnical Group.

Recommendation 1-4
Establish minimum state standards for geotechnical reports. Recognizing that not all projects will address or contain all issues, the state with input from applicable professional organizations should develop a model checklist for geotechnical reports. This checklist will aid local jurisdictions in determining the proper scope and content of reports.

Recommended Lead Agency (ies): Departments of Natural Resources and Ecology.

Issue 2

Existing maps and information are inadequate for planning and decision making.

Discussion

A December 1974 Ad Hoc Committee report on Geologic Hazards identified the need for geologic mapping to include geologic, hydrologic, and soils engineering that are significant to land use as a guide for development on a site-by-site basis. The report also identified a need for zoning, determining normal ground water conditions, and access to professional geologic and hydrologic advice for local government. At the beginning of the year 2000, these issues are still concerns.

There is a substantial need for comprehensive derivative mapping that address landslides, liquefaction zones, earthquake faults, ground motion amplification, flood plain hazards, tsunami inundation areas, underground utilities, the built environment and wild fire. However, funding for detailed mapping is generally not available at either the local or the state level.

Assessing and Mapping Risk Areas

Existing maps show some seismic, liquefaction and underground coal mine locations. By adding incremental additions to these existing maps, the cost of mapping other critical areas could be kept to a minimum.

Since some underground utilities, especially fuel transporting pipelines, are subject to catastrophic failure, they should also be added to the maps. A more detailed analysis can be applied to any given project when all the hazards are properly mapped. Coupled with detailed geotechnical analysis, a community has a better technical understanding of whether or not a site location is suitable for building.

Fire Mapping. There is a continuing need to rank and identify the location and extent of fire hazards. Specifically, there is a need for a statewide identification and mapping of extreme, high, moderate, and low fire hazard areas using a common rating system.

Homes located near forests and open grasslands face an increased risk from wildfires. Many factors play into the degree of risk including the extent of rainfall, type of vegetation, and proximity to fire fighting agencies.

In the past decade, fire-fighting agencies have faced increasing wildfires where structures and lives have been threatened or lost. A rapidly growing population with a desire to reside in natural settings continues to drive this trend. Many of these rapidly developing areas, referred to as urban interface or intermix areas, are forested settings subject to periodic wildfires. Construction often takes place with little consideration of the risk to structures from external fires or from structure fires spreading to the surrounding wildland. Consequently, wildfires claim an increasing number of homes each year: a trend likely to continue. Wildfire suppression costs are escalating as the suppression strategy is forced to change to focus on the protect homes.

In 1993, the Department of Natural Resources adopted a risk rating system (originally in use by Oregon), in cooperation with local fire chiefs, for all rural fire protection districts where DNR had wildfire protection responsibility. Fire occurrence, topography, fire producing weather events, access, and suppression capability ratings are entered into the DNR Geographic Information System. Rating factors include point scores for fire occurrence, topography, fire producing weather events, access, and suppression capability. This map was released in 1996.

Fire: Mapping Unprotected Lands. (Department of Community Development [DCD) &

Department of Natural Resources [DNR], 1994). Some areas in the state do not have fire protection for structures because they are outside the jurisdiction of local fire service agencies. These areas are not always well known or mapped, and often residents do not know they are unprotected.

Portions of the state that are not within the service area of a local fire department generally do not have structural fire protection. Other wildland areas where there are no structures may not have fire protection either. The Department of Natural Resources protects most forestlands funded by forest protection assessments. Grass lands and sagebrush areas in Eastern Washington are the most common areas that do not have any form of fire protection. Often, fires on unprotected lands are fought by neighboring fire agencies without pay, authority, and with varying degrees of liability. In 1996, the Department of Natural Resources, in partnership with the Fire Protection Policy Board, completed a study of unprotected lands and reported it to the Legislature.

Fire agencies often do not have maps that show ownership, the responsible fire agencies, physical features, or pre-fire plans. Advance planning is necessary to fight wildland fires. It is necessary to know who owns the land and who is responsible to fight the fire. Multi-agency responsibilities may occur, i.e., a fire district may be responsible for protecting structures and a wildland agency such as the Department of Natural Resources or U.S. Forest Service may be responsible for protecting forestlands. It is possible that there is no protection for some sites. Lack of clear authority can lead to confusion and ineffective initial attack. Mapping is the first step to good organization for effective fire protection. These maps should show land ownership, access roads, water sources, fire fighting resources, staging areas, and other necessary information. In 1996, with the aid of a hazard mitigation grant, the first pre-fire planning maps were created and distributed to fire protection districts and local emergency management agencies (DCD & DNR, 1994).

Coastal Hazard Mapping. The Coastal Zone Atlas, developed several years ago by the state Department of Ecology, is a mapping resource for identifying a limited scope of landslide areas in Washington. It covers an area one-half mile from shore along the Washington coast, including the Straits of Juan de Fuca. These maps only address general slopes and identify previous landslide areas. The scale (1:24,000) accommodates some site-specific evaluations, but has limitations. However, these maps provide a tool for local jurisdictions to use in determining where further study is appropriate. In addition to landslides, coastal erosion continues to destroy property, buildings, roads, and other infrastructure each year.

Wind Hazard Mapping. Maps of high wind risk areas within the state are not available, although there are some known areas like the Columbia River Gorge.

Seismic and Tsunami Mapping. Although Earthquakes are mentioned as a hazard in the Growth Management Act, many jurisdictions still do not recognize that they are in an earthquake hazard area. The Department of Natural Resources and the U.S. Geological Survey have provided some local community liquefaction mapping. More needs to be done in this area, but further mapping is constrained by existing budgets. Many local planning efforts are not including this hazard.

A southeast map, 1:250,000 scale, full-color geologic map is one of three geologic maps produced by the Department of Natural Resources replacing one produced in 1961. The southwest and northeast quadrants are also complete. The northwest quadrant remains to be produced and will likely use digital methods, as manual methods are being phased out. Geologic maps show the ages and kinds of rocks that underlie the surface and assist planners evaluate

geologic hazards (earthquakes and landslides) as well as to find natural resources. Topographic maps, which show the shape of the earth's surface, are also available.
Tsunami mapping has begun for Grays Harbor and Pacific Counties. Clallam and Jefferson County tsunami mapping should begin early in the year 2000.

Landslide Mapping. Comprehensive landslide maps will help improve hazard identification and vulnerability analysis. However, landslide mapping must take into account both the top and base of the slope in order to be effective for use in making land use decisions. These maps will also aid in determining when more detailed site-specific mapping and analysis is necessary for determining project approval.

Other than the Coastal Zone Atlas, no standardized mapping of landslide areas exists. Although the state has required each jurisdiction to identify and designate steep slope areas through the Growth Management Act, the Act does not require comprehensive mapping of these hazards. Consequently, there is inconsistent identification and treatment of potential landslide areas in different jurisdictions. As technology changes, Geographic Information Systems and digitized mapping will be common. This information must be standardized so the information can be shared.

Flood Mapping. Flood plain map shortcomings are due mostly to an inadequate volume of data. There is a lack of detailed studies in newly developed or developing areas. These areas often do not have base flood elevations of floodways identified. Present maps do not consider ground water flooding and erosion areas. This could mean that regulated areas are smaller than they should be.

Flood maps do not keep pace with growth. Upgraded flood data causes constant revisions in what elevation a 100-year flood denotes. The term "100-year flood" is actually a phrase to describe the flood that has a 1- percent per year chance of occurring. Most of the areas prone to groundwater flooding are not designated on a "100-year floodplain map."

The 1990 floods demonstrate how difficult flood flows can be to predict. Changes in land use practices, development in previously undeveloped areas, and natural shifts in flood flows can all make for surprises in terms of unexpected flood flows. These factors combine to create a situation where an increasingly large number of properties are vulnerable to flood events in a state with already inherently high flood risks.

The 1990 floods belied National Flood Insurance Program floodplain maps in many parts of Washington.
According to the King County Surface Water Management (1993), "The Thanksgiving Flood revealed widespread inaccuracies in these maps. Along several rivers, areas far outside the mapped 100-year floodplain were inundated by flows significantly smaller than the 100-year flow…. In other words, the true 100-year floodplain is wider (or narrower) than the maps indicate. Along other rivers, most notably the Raging River, the calculated 100-year flow has occurred several times in the last few years, suggesting that the true 100-year flow may be much larger. Finally, rapid channel migration-that is, the lateral movement of the channel during a flood—destroyed or severely undermined homes that are not within any mapped flood hazard area."

Flood maps proved inadequate in 1995, 1996, and in 1997. As of 1997, more than thirty-five percent of NFIP claims occurred in areas outside of the mapped "100-year floodplain." Many homeowners are finding that property that once appeared to be safe from flooding according to National Flood Insurance rate maps is now at risk.

Some Flood Insurance Rate Maps (FIRM) are outdated and do not depict future urbanization or built-out conditions. Flood insurance studies only show conditions at the time the study was completed. The frequency of some base floods has changed with increased development and changes to surface water runoff patterns within the urban watershed. Critical areas designations in the Growth Management Act do not show flood frequency changes caused by total build out of the watershed. In addition, critical area ordinances do not place additional development restrictions based on built-out scenarios. Migration or meander predictability for stream resizing or other occurrences using an unsteady model should be included, too.

Pipeline Mapping. For siting pipelines, accurate flood maps can be a benefit. FEMA and the Washington Military Department, Emergency Management Division, generally use Geographic Information System (GIS), rather than paper maps. Sharing access to the maps of the natural gas pipelines and other major utilities for emergency planning by local emergency managers or planners in affected counties in addition to the state's Emergency Operations Center would help for emergency assistance purposes.

The Federal Department of Transportation, Research and Special Program Administration, is developing a mapping system (docket number 97-426) that will incorporate GIS data on transmission pipeline locations including the ability to share information with state agencies. Future GIS data on pipeline locations should be shared with emergency management planning and response teams at both the state and local.

Recommendations

High Priority Recommendations

Recommendation 2-1
Prepare comprehensive maps of landslide susceptible areas, especially in areas of projected rapid growth (Washington State Emergency Management Division [EMD] & Federal Emergency Management Agency Region X [FEMA], 1997). Landslide susceptibility maps should identify potentially unstable areas. Natural factors contributing to the instability of these areas include steep slopes, weak geologic units, units of bluff retreat, debris flow or groundwater seeps. The susceptibility maps should serve as the primary aid to local jurisdictions in identifying areas where further, site-specific geotechnical study is needed to ensure appropriate land use and construction. Mapping should focus on areas of rapid growth: tie them into the growth management planning when available and use this information as a guideline for rural areas.

Recommended Lead Agency (ies): DNR with the assistance of Washington State Department of Community, Trade, and Economic Development (DCTED), U.S. Geological Survey (USGS), Seattle- ASCE Geotechnical Group, (possibly Washington Geographic Information Council). Prerogative of local jurisdiction.

Recommendation 2-2
Enhance flood maps to reflect actual flow rates, using cubic foot per second contours. Maps should incorporate riverine, stream, and significant groundwater events. A flow map would be easy to maintain. You can use the map to compare rates of discharge, and make amendments as needed.

Recommended Lead Agency (ies): Ecology and Federal Emergency Management Agency - Region X (FEMA), with support from the USGS for mapping suggestions.

Recommendation 2-3
Encourage flood map updates that include fully developed areas and/or the built-out environment. Consider historical weather data as well as building and land for its cumulative effect on the environment. This is especially necessary when calculating flood frequency and development policy within urban watersheds.

Recommended Lead Agency (ies): Ecology; DCTED-Growth Management Services (GMS), and FEMA. Prerogative of local planning, storm water, and public works departments.

Medium Priority Recommendations

Recommendation 2-4
A hydraulic analysis of any watershed should go beyond the traditional HEC-2 modeling in order to provide an accurate portrayal of conditions relating to the unsteady state conditions that exist. In the long term, a program that addresses cause and effect in an entire river basin would enhance the opportunity to identify mitigation measures and reduce existing and potential flood hazards. A pilot inventory of river basins should be developed to determine the potential problem areas, including ice jams or over-topping sections of levees, and develop alternative hazard mitigation plans. Other issues should be a comprehensive analysis of all transportation facilities, as well as the concerns of other regulatory agencies, and private interests. In terms of modeling, ice is considered the same as debris. A suitable funding mechanism would be necessary for the agencies.

Recommended Lead Agency (ies): Ecology, Fish and Wildlife, DNR, and Washington State Department of Transportation (WSDOT), U.S. Department of Agriculture Natural Resources Conservation Services (USAG-NRCS), FEMA, and USACE.

Recommendation 2-5
Re-inventory and map the Coastal Zone Map, using current technology.

Recommended Lead Agency (ies): Ecology and DNR.

Recommendation 2-6
Develop tsunami inundation hazard maps for additional, vulnerable communities.

Recommended Lead Agency (ies): DNR and Washington State Emergency Management Division (EMD). Prerogative of local jurisdiction.

Recommendation 2-7
Geotechnical, geologic, and hydrologic (including groundwater, riverine or stream floods, and snow depths) reports should be recorded as a part of the public record. Each local jurisdiction and the state should develop an archival system to retain these reports to form a history for specific hazards. In this way, information can be consolidated and used in future analysis of site conditions. It also can be a resource in identifying the success or failure of particular mitigation measures. The recording of these reports submitted for permits will provide a mechanism for instance, of identifying or disclosing the associated risks of purchasing property in a steep slope or landslide susceptible area. Permit requirements and conditions of approval should be noted on the title of properties to aid in disclosure at the time of sale.

Recommended Lead Agency (ies): DNR and Secretary of State's Office, local jurisdictions, and possibly the Washington Geographic Information Council.

Recommendation 2-8
The Department of Natural Resources currently maintains a geologic database. The legislature should designate (with appropriations for staff) a state agency to develop and maintain a master repository of all geotechnical, geologic, and hydrologic historical data, including landslides, using the Geographic Information System (GIS). Many local communities use GIS. A permit applicant would submit two copies of the geotechnical report during the permit process. One copy remains with the local jurisdiction and the second goes to the designated agency for inclusion in the database. Privately paid reports may cause some legal concern. Sections of privately paid reports may need to be marked,

"not for public record." However, the details for handling reports of this nature are the responsibility of the applicable government agency (ies).

Recommended Lead Agency (ies): DNR, WSDOT, Ecology, Secretary of State's Office, local jurisdictions, and possibly the Washington Geographic Information Council.

Recommendation 2-9
Establish a groundwater or other hazard data repository comparable to that recommended for the geotechnical, geologic and hydrologic database. The legislature would need to appoint the state agency with the most appropriate need for this historical data, such as the Departments of Ecology or Natural Resources.

Recommended Lead Agency (ies): Ecology or DNR.

Issue 3

Flooding continues to be the most frequent cause of disaster in the state. Development, combined with clear cutting and other land management practices continue to exacerbate the threat of flood hazards to people and property and contributes to erosion throughout the state.

Discussion

State Environmental Laws

There are several environmental laws, including chapter 86.26 of the Revised Code of Washington (RCW) that sets the requirements for state comprehensive flood control management (plans) and chapter 86.16 RCW, that establishes floodplain management regulations. The concepts of both, address flood hazard management.

Development and Land Use Practices.

Despite the continued efforts of the public and private sectors, the cost of flood damage is growing. Flood events surprise existing communities when development patterns divert storm flows into otherwise safe areas. "Urbanized areas flood easily because of the decreased infiltration capacity of the land surface resulting from buildings, paved streets and parking lots, and sidewalks" (United States Geologic Survey, 1991, p. 80).

Flood warnings, for some rivers and streams, were changed by local jurisdictions in 1997. This is due in part to the accumulation of significant deposits of debris or gravel over the course of time which causes flooding quicker than in the past. The earlier warning provides more time for safe evacuations based on current water basin conditions.

Local governments are struggling to mitigate flood impacts. However, development in our state, combined with clear cutting, exacerbates local efforts.

Structural and Nonstructural Measures

Many local governments have enacted land use regulations and construction standards that protect structures from flood hazards. Measures like these that do not require physical construction are categorized as nonstructural measures. Structural measures to reduce damage depend upon construction of dikes, levees, and drainage systems.

Nonstructural measures can offer considerable savings when compared to structural measures.

Structural Controls. Structural measures attempt to alter storm flows, which can have unpredictable results. "Levees can cause problems in some critical reaches by backing water up on other levees or lowlands" (Galloway, 1994).

Structural measures may shift floods to other areas vulnerable to flood damages or fail in containing floodwaters altogether. "Changes in the channel and floodplain itself can… impact other parts of the stream system. Confining the channel with levees, for example, can create backwater flooding upstream, increased erosion downstream and greater sedimentation in the channel itself. Dredging river channels can lead to increased erosion downstream in both the mainstream of the river and its tributaries. In other words, few actions in a watershed are without consequences for other parts of the drainage system (King County Surface Water Management, 1993, p. 64).
When structural measures fail, damage can be great. "Many locally constructed levees breached and/or overtopped. Frequently, these events resulted in considerable damage to the land behind the levees through scour and deposition" (Galloway, 1994).

Developments, depending upon the success of structural measures, will be particularly vulnerable to flood damage during incidents if these measures fail.

Traditional bank protection projects tend to be hard structural facilities such as dikes and levees. Repair projects for these structures invariably favor rebuilding to pre-damage structural specifications. This situation eliminates, or at least inhibits, the possibility of installing bio-engineered bank stabilization projects using vegetation. Further complicating this issue are the varying policies of resource and regulatory agencies relating to vegetation management between the Corps of Engineers, Ecology, Department of Fish and Wildlife (both state and federal), Natural Resources Conservation Service, the Indian Tribes and Nations, and local governments. When there is a conflict of timing for obtaining exemptions or expedited permits or full, reimbursed funding, there is a greater chance that environmental enhancement or mitigation efforts will not occur.

Existing Structural Flood Control Measures. The U.S. Army Corps of Engineers and, to a lesser extent, the U.S. Department of Agriculture's Natural Resource Conservation Service has proposed several large-scale flood control projects. However, due to the cost and environmental considerations only a limited number have been built. "Major levee construction often exceeds $1 million per mile and flood control dams often cost tens of millions of dollars" (Department of Community Development, 1993, p. 2.).

Several rivers around the state have dams, but most of these dams were built for hydropower, municipal, and industrial water supply, or irrigation. Some dams in Western Washington, constructed and operated by the U.S. Army Corps of Engineers, are designed specifically for flood control. These dams include the Mud Mountain Dam on the White River, the Howard Hanson Dam on the Green River, and the Wynoochee Dam and reservoir on the Wynoochee River.

Other flood control projects include the Mill Creek Reservoir, one of the largest off-stream flood storage projects in the state. This reservoir protects the Walla Walla urban area from flood damage and major levees built to protect low areas around Kennewick, Pasco, and Richland. Several other smaller flood control projects continue to work as designed.

Many Western Washington rivers have a variety of artificial dikes and channel systems in the lowland areas to help in passing the peak flood flows, but none of these systems totally prevents flooding in the lowlands. Substantial portions of the floodplains along these rivers remain subject to regular flooding. Major storage reservoirs built for other than flood control purposes on the Columbia River and its major tributaries, have reduced flooding on the main stem.

Nonstructural. Nonstructural flood damage reduction relies on identifying historical storm

flow data and then accommodating these flows. Because nonstructural measures avoid the cost of construction projects, many local governments are trying to use these in their damage reduction efforts, especially for floods. State and federal agencies share this interest. In order to be successful, jurisdictions should work together in planning and sharing information resources and coordinating hazard damage reduction efforts. Such measures can avoid the expense involved in building flood control structures. Most attempts to reduce flood losses in the state have been relatively small-scale local efforts carried out project-by-project.

Despite the advantages of nonstructural flood damage reduction measures, they can be difficult to carry out. These measures demand careful planning and political commitment in order to work. Additionally, the success of these measures may depend upon the cooperation of more than one jurisdiction. Watersheds do not follow political boundaries and all communities in a watershed are affected by what happens. Successful nonstructural measures may demand coordination among several jurisdictions, including Idaho, Oregon and the British Columbia, Canada, border communities.

Many areas in Washington, including the Touchet River, Latah Creek, Asotin Creek, Pine Creek, and the Puyallup River all experienced lateral channel migration and bank erosion in the 1996-97 winter storms that complicated the implementation of repair solutions. The natural course variability or migration of rivers and streams should be studied. There needs to be a balance between land use and natural habitat when considering nonstructural solutions to this type problem.

Discharges along urban streams resulted in substantial damage to the river corridors and floodplains during the 1996-97 winter storm events. Changes to stream systems altered or severely damaged existing habitats, which increased the risk of damage in future floods. In seeking solutions to these problems, a balance must be struck between habitat preservation and structural solutions.

Flood damage in urban streams includes bank erosion of private property owners. Restoration by conventional methods of riprap and bulkheads further degrades the river habitat values. Technical information on bank stabilization options for private homeowners is available through the U.S. Fish and Wildlife Service and the Natural Resources Conservation Service. Cost-share programs concerning bio-engineered stream bank stabilization techniques are also available. The National Park Service, Rivers, Trails, and Conservation Assistance Program, helps in advocacy and identifying resources for assisting communities improve public awareness about comprehensive watershed planning and resource conservation (Rivers, Trails and Conservation Assistance Program & Association of State Floodplain Managers, Flyer).

Building codes and zoning keeps houses and facilities away from flood hazard areas provided the area is not already built out. Placing less vulnerable populations like businesses (if they meet flood-proofing criteria) in flood hazard areas instead of housing projects, may also be a solution in reducing both the vulnerability and the risk to future floods. Combined with open space and redeveloped wetlands, this nonstructural mitigation measures could greatly benefit a community and the environment.

The Department of Natural Resources administers the Aquatic Lands Enhancement Account, which is revenue generated by management of various state-owned aquatic lands and resources. These funds have been used to increase public access to public waters, build trails, and educate the public about the value of the state's aquatic resources. As a part of this effort, the funds have been used in conjunction with federal, state, and local matching funds to purchase flood damaged homes, relocate affected

residences and restore habitat and/or provide public access.

Recommendations

High Priority Recommendations

Recommendation 3-1
Simplify and shorten the permitting process for flood damage reduction and stream improvement projects.

Recommended Lead Agency (ies): Ecology, DNR, and Fish and Wildlife.

Recommendation 3-2
Develop a technical information manual on bank protection options that encourages enhancing habitat values for use by private property owners.

Recommended Lead Agency (ies): Ecology and Fish and Wildlife with assistance from the U.S. Fish and Wildlife Service and USAG-NRCS Service.

Medium Priority Recommendations

Recommendation 3-3
Develop an interagency agreement on bank stabilization funding and policies among the resource and permit agencies.

Recommended Lead Agency (ies): Ecology, USAG-NRSC, USACE, and FEMA.

Recommendation 3-4
Flood Control Facilities Repair. Communities should identify suitable sites for bio-engineered bank protection. Priority funding for such environmentally sound vegetation bank protection projects should be established by responsible agencies. The siting of infrastructure projects should consider vegetation buffers. Vegetation management standards need to be area specific. Mutually agreed-upon design standards and vegetation values need to be established for bio-engineered projects, yet still allow for site-specific flexibility. Legislative directives at the state and federal levels regarding standards and funding may be required.

Recommended Lead Agency(ies): Ecology with support from the Department of Fish and Wildlife, USAG-NRCS, Indian Tribes or Nations and USACE.

Recommendation 3-5
Channel Migration. Perform hydrological studies of lateral channel migration and bank erosion streams to determine the most viable repair and mitigation measures. Consider land use practices along reaches subject to this phenomenon carefully. Because of the 1997 floods, at least four such studies will take place. The studies will most likely occur along Pine, Latah, and Asotin Creeks and the Touchet River.

Recommended Lead Agency(ies): Ecology with support from USACE.

Recommendation 3-6
Urban Stream Flooding Regulations and Legislation. Evaluate current state programs to identify inconsistencies, the adequacy of the minimum standards, and other regulatory issues that are needed in the state's effort to reduce flood losses. This evaluation should include each program's current efforts to address: 1) total watersheds, both upland and lowland; 2) the coordination or consolidation of fragmented drainage and diking districts; 3) the role of storm water management in flood loss reduction planning; and 4) preservation and acquisition of designated wetlands or other lands to hold flood waters.

Recommended Lead Agency(ies): Department of Ecology.

Recommendation 3-7
Explore potential funding sources for use in flood mitigation. Funding is needed for: 1) acquisition or preservation of designated

wetlands or other land to accommodate flood waters; 2) relocation or retrofitting of existing development in flood prone areas; and 3) other measures to reduce or eliminate flood damage.

Recommended Lead Agency(ies): Ecology; DCTED, and EMD.

Recommendation 3-8
To encourage flood damage reduction activities, the Ecology program staff should modify the application process and funding guidelines, within current regulations.

Recommended Lead Agency(ies): Ecology.

Recommendation 3-9
Present natural hazard (landslides, floods, earthquakes, etc.) workshops for local officials that address the limitations of structural control mechanisms, prevention or lessening of landslide and flood damage through nonstructural means, and remedial measures for damaged property.

Recommended Lead Agency(ies): DNR and Ecology. Prerogative of local jurisdictions.

Low Priority Recommendations

Recommendation 3-10
Create storm drainage system standards that coordinate variables such as retention, duration, and peak as related to the system and the body of water, helping to better calculate and minimize the volume coming through the system.

Recommended Lead Agency(ies): Ecology and local surface water agencies with support of public works agencies.

Recommendation 3-11
Increase peak flow levels in development standards from one-day peak to a seven-day sustained peak.

Recommended Lead Agency(ies): Department of Ecology's Water Quality Program, USGS, and USACE. Local public works and surface water management agencies.

Recommendation 3-12
Develop a model ordinance that includes specific language for residential drainage systems, including foundation drainage, downspout drainage and the connection of the foundation and downspout drainage to a storm water drainage system based on site specific soil group types.

Recommended Lead Agency(ies): DCTED and Ecology.

Recommendation 3-13
Consider amending Section 1824.3, Appendix Chapter 18 of the Uniform Building Code for 1998 to be mandatory. Community Trade and Economic Development and Department of Ecology should co-sponsor legislation mandating residential storm water drainage systems if it is determined that rising water tables is a statewide issue.

Recommended Lead Agency(ies): DCTED and Ecology.

Issue 4

Landslide hazards are becoming more prevalent and constitute a significant risk to people, property, and the infrastructure. The identification of landslide prone areas, development of effective mitigation strategies, land use management, and sufficient numbers of knowledgeable and qualified (certified) professionals capable of defining the threat need to be addressed.

Discussion

State Environmental Laws

Several planning and environmental laws within the state provide opportunities to integrate effective approaches and controls in landslide prone areas. The Growth Management Act (GMA, chapter 36.70A RCW) addresses land use planning throughout the state, as well as the treatment of critical areas such as steep slopes. The Land Use Commission was tasked to review all environmental code for consolidation by June 1998, although the focus was on growth management and shorelines. The Shoreline Management Act (SMA, chapter 90.58 RCW, and Title 173-16 WAC) addresses land use within 200 feet of a shoreline of statewide significance. The State Environmental Policy Act (SEPA, chapter 197-11 WAC, SEPA rules, and chapter 43.21C RCW, State Environmental Policy) addresses the environmental impacts of proposals within each jurisdiction. These laws may be supplemented with the requirements of the state or local jurisdictions for development in hazard prone areas.

Since most landslide damage is related to human activity in sensitive slope areas, the best opportunities for reducing landslide hazards are found in land use planning and administration of codes and ordinances.

Land Use Restrictions

The best mitigation strategy for slopes prone to failure is not to build on or near them. However, with increasing development pressures, high "view property" values and the general desirability of living on bluff property, a total prohibition of building near landslide prone areas is not realistic, practical, or desirable. Rather, local jurisdictions need to take reasonable measures to prohibit or restrict development in areas where remedial measures are not effective or feasible.

Where measures can be taken to stabilize slopes development could be permitted, if appropriate slope stabilization and maintenance can be assured. Such measures might include establishing buffer zones near landslide hazards through property acquisition, easement, or increasing set back requirements. The scope of these restrictions should be examined by legal counsel considering takings as well as nuisance abatement (condemnation of property by a local jurisdiction to abate a hazardous situation). Guidelines for condemning hazardous property or structures should be predetermined and standardized. Alternative measures such as relocation or removal of permanent structures should also be predetermined and approved through open meetings.

Once a landslide has occurred in a developed area, appropriate hazard mitigation measures must be considered to minimize further damage or salvage damaged structures. Because of the continuing nature of landslides and the considerable expense in establishing a permanent solution, once a slide has occurred mitigation choices are often very limited. Where earth movement is slow, and time allows, relocation may be the only alternative to salvage structures or equipment in immediate peril from the slide.

In areas where the landslides will not result in immediate and total destruction of structures, voluntary acquisition and relocation programs

are unlikely to be effective. In Washington, high property values, expensive housing and preferences for view property provide a considerable incentive for bluff property owners to remain in high risk areas, particularly when options are available to prolong the stability of the hazard area. For this reason, and in this situation, slope stabilization is the preferred method of mitigating landslides.

Slope Stabilization

When time is not critical for selecting options in order to stabilize an area, slope stabilization is the preferred method of mitigating landslides. The primary components of slope stabilization are grading, groundwater, drainage, vegetation management, and other structural controls.

Slope stabilization is an issue during earthquakes, landslides, and coastal erosion. Several erosion control and vegetation management resource documents, developed between 1993 and 1995, are available from the Department of Ecology.

Grading. As with many of the other mitigation measures recommended for landslides, grading can increase either the stability or the instability of a slope, depending on how it is performed. The key to ensuring that grading is performed in a manner that will not add to the risk of slope failure is proper engineering and design. The type of soil, height of fill or cut, and soil compaction are essential components of appropriate grading in landslide susceptible areas. Contouring and undercutting the toe of a slope that is not engineered may lead to destabilization, as might the placing of improperly compacted artificial fill in such areas.

Rising Groundwater Levels. Areas throughout Washington have experienced high groundwater tables in recent years. These levels are attributed to a series of record precipitation events that occurred during the winters of 1995-96 and 1996-97. Many closed basin lakes reached all time highs in January 1997. Numerous small, flat urban and suburban basins flooded in 1996 and held water through the summer of 1997.

Filling of wetlands, expansion of impermeable surfaces due to development and inappropriate development in large drainage areas compound the problem. Many jurisdictions plan for storm-water runoff, but do not plan for groundwater saturation. Critical area ordinances do not require the identification of high groundwater levels, and mapping of these areas is rare. In addition, groundwater problems are sometimes transient appearing several blocks away during the next episode. Most development is not required to supply groundwater analysis, only surface water runoff. Information and technical assistance is needed for property owners in identifying problem sites, methods of handling, and the effects on septic systems and well contamination.

Drainage. Many homes constructed without drainage systems incurred damage from water seepage through basement floors, walls, and foundations in the 1995-97 winter storms. Downspouts were not connected to drainage systems and drainage systems were not connected to storm-water systems, all of which compounded the damage.

Standards for regulating onsite drainage including foundation drains, downspouts, and connections to approved storm-water systems are found in Section 1824.3, Appendix Chapter 18 of the 1994 Uniform Building Code (UBC) as adopted by Washington State. Standards for storm-water drainage systems are found in the State of Washington Puget Sound Water Quality Management Plan (PSWQMP). Many communities have adopted the PSWQMP or developed their own equal or higher standards. However, the PSWQMP does not address foundation drainage and UBC standards are at the discretion of the local building official.

Although landslides occur naturally in developed as well as undeveloped areas, control of surface and subsurface drainage, to include sprinkler systems, onto landslide susceptible areas, will reduce the likelihood of future slope failure and severe erosion. Proper drainage control can be one of the least expensive approaches to reducing excessive saturation of slopes and subsequent failure.

Special Districts. One method to effectively implement hazard mitigation, such as for landslides, is to create local improvement districts (LIDs) or "Natural Hazard Abatement Districts." Rather than address slide control in a piecemeal or lot-by-lot basis, a local improvement district can mitigate area-wide contributors to slope instability. For example, in a neighborhood where drainage is directed toward a potentially unstable slope, a local improvement district could address the entire area which may encompass several dozen lots as well as area infrastructure, rather than individual efforts focusing on a single lot's drainage. These districts also may qualify for funding sources for which an individual would not be eligible. The Small Business Administration, for example, in 1997 offered up to $1.5 million in loans for local improvement districts, while the funding available to individual property owners for the same type of problem would be substantially less.

Sanitary Systems and Utilities. Improper location of sanitary systems and utilities may contribute to slope instability. For example, septic tank drain fields inject substantial amounts of water directly into the ground to cleanse effluent. A three bedroom, single-family dwelling may have up to 900 gallons of water per day flow through such a system. When septic drain fields increase soil saturation above that of normal precipitation, groundwater, and surface water drainage, it increases the susceptibility of the slope to movement.

Many residences that were damaged or threatened by landslides during the 1996-97 winter storms had septic drain fields either immediately above or within areas of slope failure. In some instances, homes were located near the toe of a slope, while effluent was pumped to a drain field above the top of the slope. Where these slopes failed, a substantial contributing factor to the structure's damage was its own drain field. Before local jurisdictions issue permits for drain fields or storm-water retention/detention facilities, the potential affect of location in relation to landslide susceptible areas needs to be considered. Dry wells also are common contributors by allowing direct disposal of surface runoff into the ground; thus, effectively raising the groundwater table by forced injection. Slides can occur due to the increased seepage.

Another concern occurs when a landslide damages utilities in or near landslide susceptible areas. During the 1996-97 winter storms, landslides disrupted numerous utility services ranging from electric to sewer service

Drainage Control Plan. Increased groundwater flows and surface water discharges in landslide susceptible areas are often the essential triggers to slope failure. The increase in saturation levels is evident when comparing areas and times where slope failures have occurred with precipitation levels and locations. Most often, slides occur during or immediately after heavy rainstorms. The precipitation levels of the 1996-97 winter storms, in ordinary circumstances, may not have resulted in as many slope failures if it had not been for the abnormally high precipitation levels in previous years combined with the snow melt. The high precipitation levels resulted in high groundwater tables and relatively low capacity of the soil to absorb additional water.

Evaluation of site drainage is an essential mitigation component in landslide susceptible areas. Common factors contributing to excessive slope saturation are site drainage directed toward

the top of slopes; draining of pools or hot tubs onto slopes; downspouts discharging at the top of slopes; septic tank drain fields; drywells; undersized culverts; and inadequate street drainage.

Drainage System Standards. Many storm drainage systems are outdated. The methods currently being used to project needed capacity are inadequate. Disclosure in real estate purchasers is not required. Developments with less than six houses do not need a water rights permit for a well. Many private drainage systems later taken over by public entities have caused problems due to the minimal standards to which these were designed. One-day peak flows are not adequate for development standards with today's growth. While developers currently have to post a one-year performance bond in most cases for drainage systems, the period is too short to see if the system works. Natural drainage system maintenance may be either an individual or a community responsibility.

Vegetation Management. Generally, the preferred means of protecting an undisturbed slope that has appropriate, stabilizing vegetation is to not disturb it. Establishing this vegetation can improve soil conditions, does not require large capital outlays, and often yields the greatest mitigation benefits through root stabilization of slopes. Vegetation also is important for interception and evapo-transpiration of precipitation. Interception is vital not only for the slope, but is also vital in areas hydraulically upstream of the slope as well. However, vegetation alone is not usually adequate to fully mitigate landslide hazards on Puget Sound bluffs.

Ground covers with a very shallow root system are not effective for slope stabilization and can exacerbate instability. Similarly, plants that require prolonged or excessive irrigation (generally non-native species) may increase slope saturation and instability. Caution must be made to prevent the infestation of noxious weeds in these areas that could overrun the native covers. Blackberry vegetation, found on Puget Sound slopes, is both common and native. The Himalayan Blackberry intercepts moisture in the summer, fall, and early winter and the dropped leaves form an important organic soil layer that provides moisture interception. Pines and firs are not deep-rooted. Large firs have a root structure of 3-to-6 feet in depth and over one acre of surface area for interception and evapo-transpiration, yet cedars and other trees with a taproot provide a more significant slope stabilization factor.

While deep rooting, native vegetation provides good erosion control as well as good ground cover in landslide susceptible areas, often these are removed to facilitate views. This practice removes the stabilizing structure of the slope and often results in failure. In addition to maintaining appropriate vegetation on and in slope areas, materials (i.e., straw/wood chips, geotechnic erosion control mats, reseeding, mulching, and woven burlap/mesh can be incorporated into landscaping to strengthen soil to resist erosion. Preventing infiltration mitigates a major cause of landslides. Setback requirements for homes may not always be sufficient nor an assurance for stability. When decks and porches are added to extend out over the slope, vegetation is generally removed. This combination can cause or contribute to slope failures. Landscape berms also can add more weight on a slope.

Structural Controls. In areas where extensive re-vegetation is not practical or will not result in acceptable levels of slope stability, structural controls may be the only means to protect existing land use. Solutions, which may include features like engineered retaining walls, rip-rap, impact walls, counterweight fills, debris walls at the base of steep bluffs, catch basins, stem walls, piling, buttresses, or regrading may provide effective protection with appropriate location and design. Without proper design and analysis, structural features may create a false sense of protection from the hazards associated with

landslides, and in some cases even increase the risk of slope failure. The same can be said for flood control structures.

Planning. Assessing the interaction of *v*egetation with the slope and other environmental conditions, is an important element of mitigating hazards in landslide susceptible areas. These considerations should be included in the geotechnical report, as should continuing maintenance of the site. Minimum standards for vegetation management are best set forth in a plan developed by government agencies as well as private or public organizations.

Debris Management and Maintenance. A factor contributing to slope failure in landslide susceptible areas is the loading or creation of additional weight at the top of a slope. The relatively common practice of disposing of trash, construction rubble, land clearing debris or yard waste on steep bluffs increases slope instability. Such debris accumulations substantially increase the weight on the slope over time, as well as potentially adding hazardous components to the debris (i.e., illegally dumped toxic chemicals from paint cans, and motor oil).

Recommendations

High Priority Recommendations

Recommendation 4-1
Vegetation Management. Appropriate parties need to agree on vegetation management standards. This is also appropriate for wind, ice, flood, wildfire, and earthquake or other damages.

Recommended Lead Agency(ies): Departments of Fish and Wildlife and Ecology.

Recommendation 4-2
Review the State Forest Practices Act. The Forest Service Practices Board should be consulted regarding possible revisions to the State Forest Practices Act to lessen the risks to utility and transportation routes.

Recommended Lead Agency(ies): DNR, WSDOT, DCTED, and the Washington Utilities and Transportation Commission (WUTC).

Medium Priority Recommendations

Recommendation 4-3
Prepare a zoning model ordinance addressing slope stabilization (EMD and FEMA, 1997). The state should develop a model ordinance relating to slope stabilization and minimization of landslide hazards for use by local jurisdictions and the Uniform Building Code (Grading, Paving, and Excavation) should be incorporated as mandatory. This model ordinance should, first, discourage or prohibit development in landslide hazard areas, as well as alluvial or debris fans of previous landslides. Such areas should be zoned for open space or recreational uses in undeveloped areas. Alternatively, a local jurisdiction could create buffer zones from the base and top of landslide susceptible areas where development would otherwise be appropriate.

The model ordinance should also encourage a slope density-zoning scheme that decreases development densities as slope angles and landslide susceptibility increases. Note that inherent within mandating must be enforcement or adaptability. The building industry, Growth Management, and the legislature need to address this issue.

The model ordinance should also encourage local jurisdictions to place more of the responsibility and costs of mitigation and landslide related damage on those individuals benefiting from the development of such areas. One way to accomplish this would be to have property owners maintain access roads when buildings or structures require access in steep slope areas. When local agencies privatize these areas, maintenance and mitigation will not fall upon the public's shoulders, but will be the responsibility of individuals who benefit from development in landslide susceptible areas.

In addition, when development is proposed, the local jurisdiction should incorporate a cost-benefit analysis that addresses landslide mitigation before project approval. Such an analysis should address the potential damage to roads, infrastructure, and emergency services. Proposed projects also should assess and minimize the impacts of construction on both developing and adjacent property as addressed through the State Environmental Policy Act. Minimization of impacts from proposed development might come from project and site design, such as allowing debris flow areas or building design that provides structural reinforcements or breakaway areas (Federal Emergency Management Agency, 1997).

Recommended Lead Agency(ies): CTED, DNR, Ecology, and Association of Building Industry. Local jurisdictions

Recommendation 4-4
"Catchment structures upstream from populated parts of valley floors could provide effective mitigation if they contained adequate unused storage to trap a lahar" (U.S. Geological Survey Cascade Volcano Observatory, 1997). Similar systems are in place on the Cowlitz, Nisqually, and White Rivers. Other locations may be appropriate.

Recommended Lead Agency(ies): DNR, Fish and Wildlife, Ecology, USAG-NRCS, and USACE. Prerogative of local jurisdictions.

Recommendation 4-5
The cumulative effects of surface runoff and rising groundwater levels should be addressed.

Recommended Lead Agency(ies): Ecology and local surface water agencies.

Recommendation 4-6
Establish a training team consisting of local engineering geologists and geotechnical engineers, to give technical assistance to governmental agencies in understanding and implementing the landslide hazard identification technical manual. A 9 May 1997 letter from the Department of Natural Resources indicated it would take an additional seven or eight staff years and approximately one million dollars to complete this recommendation and to develop minimum state guidelines for assessing landslide hazard areas. (Recommendation 1-3).

Recommended Lead Agency(ies): Department of Natural Resources with assistance by the Seattle American Society of Civil Engineers, Geotechnical Group.

Low Priority Recommendations

Recommendation 4-7
Zoning exists in certain potential lahar inundation zones to restrict urban development. However, the zoning does not restrict low-density development nor does it reduce the population density in urban enclaves that predated zoning restrictions (U.S. Geological Survey Cascades Volcano Observatory, 1997). Communities need to assess these potential problems.

Recommended Lead Agency(ies): DCTED-GMS. Local government.

Recommendation 4-8
Vegetation Management. Encourage utilities to maintain a comprehensive vegetation management program addressing wind, fire, landslide, or other potential hazards.

Recommended Lead Agency(ies): DNR, Washington Utilities and Transportation Commission (UTC). Public and private utility companies.

Recommendation 4-9
Develop public education materials that show the benefits of installing adequate storm water drainage systems. Distribute these materials to builders and owners.

Recommended Lead Agency(ies): Department of Ecology, Water Quality Program. Prerogative of local agencies.

Issue 5

Transportation is essential to Washington's vitality. The risk to local bridges, marine and port facilities, highways, transit systems, airports, and rail facilities from earthquakes, flooding and landslides must be determined so that priority can be given to mitigating critical routes, staging areas and airport facilities.

Discussion

Transportation corridors throughout the state of Washington are vulnerable to a number of natural hazards including floods, landslides, volcanic ashfall, earthquakes, tsunamis, winter storms, and even windstorms.

In Western Washington, a single major corridor, Interstate 5, provides access north and south through the state. The most vulnerable part of this infrastructure stretches from Everett to Olympia, an area laced with earthquake faults. Major sections of the interstate cross or border known liquefaction zones. The area has also experienced numerous landslide problems and sporadic flooding of the roadway in several locations.
Many bridges and overpasses constructed along this stretch are at risk as well. A 40-year *bridge retrofit program* is underway in Washington. The project focuses on primary transportation routes and includes jackets to prevent column bursting.

South of Olympia, in the Centralia-Chehalis area, I-5 is frequently exposed to floodwaters from the Chehalis River. During the 1995-97 winter storms, flooding on the Chehalis River and its tributaries, including the Skookumchuck River, caused repeated road closures and obstructions on Interstate 5, Highway 12, and local roadways in the surrounding communities. The Washington State Department of Transportation (WSDOT) has considered widening and elevating Interstate 5 for the length of the Centralia-Chehalis corridor to mitigate repetitive flood damage.

Interstate 90, the primary corridor between Seattle and Spokane crosses Snoqualmie pass, an area where snow avalanches frequently close the roadway in winter months. I-90 is also vulnerable to the Seattle earthquake fault, especially in areas near the intersection of I-5 and I-90, through Mercer Island, and where I-90 runs adjacent to Lake Sammamish. I-90 has a floating bridge across Lake Washington that has proven vulnerable to high winds. In past years, the bridge was damaged during a windstorm and sank.

Highways 2, 12, and 20 also cross the Cascade Mountains providing additional routes east and west. However, they also cross high mountain passes frequently closed by heavy snow and avalanches. Landslides have also closed Highway 12 in multiple areas. Highway 20 closes each winter due to heavy accumulations of snow and the high cost of keeping it clear.

Railroad routes running north and south are subject to landslides as they pass beneath the steep bluffs of the Puget Sound. They are also vulnerable to earthquake damage as they cross earthquake faults and liquefaction zones. Past earthquakes have bent the rail and destroyed the rail bed in some areas. East and West railroad routes either cross the Cascade Range or follow the Columbia River. Routes crossing the mountain passes are subject to winter storms and avalanches. One of the states highest death tolls from a disaster occurred when a passenger train crossing the Cascade Mountains was caught in an avalanche. Routes along the Columbia River are subject to flooding and landslides.

Ferries provide vehicle and passenger service throughout the Puget Sound offering some relief to highway traffic congestion. However, many ferry terminals are built in liquefaction zones and may not be functional following an earthquake. The ferry fleet is also vulnerable to various weather related events.

Washington is highly dependent on foreign trade that enters the state through the shipping ports of Seattle and Tacoma. Both of these ports are in known liquefaction zones and may not survive an earthquake. The primary land route serving these two ports is I-5, which may also be heavily damage in an earthquake. Should this happen, the state's economy suffer immeasurably.

In an attempt to mitigate this situation, King and Pierce Counties joined together in a Project Impact Program in 1999 addressing the economic vulnerability of the transportation corridor between the Tacoma and Seattle ports. The project emphasizes the extreme vulnerability of local infrastructure to earthquakes, especially infrastructure in known liquefaction zones. King and Pierce Counties asked the United States Department of Transportation, in cooperation with the Washington Department of Transportation, to mitigate this vulnerability through additional funding and prioritization of infrastructure mitigation projects, such as bridge retrofits.

In recent years, roadways in nearly every county have experienced one or more road closures due to natural and technological hazards.

Landslides are a problem, particularly following heavy rains. Consequently, in 1996, the Department of Transportation conducted an inventory assessment of landslides and unstable slopes along all state functionally classed systems.

Ice and long periods of high temperatures also take a toll on the transportation system. In times of extreme heat, railroad rails, and roadways can be deformed, much the same way that freezing temperatures and moisture cause ice heave in winter months.

During freezing weather, riverbanks can freeze and when the ice breaks away from the banks, it can create ice jams. The ice jams, if not broken up, tend to dam the river causing floods. These floods may knock out bridges, over-top highways, isolate people and communities and could cause death or injury. During the 1996-97 winter storms, a damaged levee on the Nooksack closed access to roadways isolating 8,000 people.

The water saturation, frozen ground and icy conditions produced during the 1996-97 winter storms proved that the base of some roads were not built strong enough to withstand heavy truck traffic. Weight limitations were imposed to prevent damage to the roadways. The combined depth of snow and ice (up to five inches) and long duration of freezing temperatures affected traffic and caused accidents.

During volcanic eruptions, ash accumulations can cause extremely dangerous driving conditions, closing transportation routes and affecting equipment, vehicles, and the population, a lesson learned well during the eruption of Mount St. Helens.

Communities throughout the state must evaluate the vulnerability and risk to the transportation infrastructure and act to ensure its survivability to all hazards.

Recommendations

High Priority Recommendations

Recommendation 5-1
Assess the disaster survivability of lifeline routes to include state and local roads, bridges, transit routes, railroad, and port facilities. Determine appropriate retrofits and prioritize emergency routes.

Recommended Lead Agency(ies): WSDOT.

Medium Priority Recommendations

Recommendation 5-2
Continue efforts to plan for and protect rail facilities from damage. Rail facilities are vulnerable to all geological failures, like landslides or soil movement that blocks or displaces tracks. Some efforts have occurred to reduce vulnerability, especially in the movement of hazardous materials through populated areas.

Recommended Lead Agency(ies): WUTC and railroad companies.

Issue 6

Mitigation is key in reducing future damage from any number of hazards. However, there is currently little incentive for communities to plan for or initiate pre- and post-disaster mitigation projects.

Discussion

Much like preparedness, individuals as well as communities find little motivation to mitigate the effects of disaster. There are many reasons for this. Some may think it is wasteful to fix something that has yet to break. Other may think mitigation is too costly, and still others may lack the political will to elevate mitigation to a high level amidst a myriad of other priorities. There are undoubtedly a number of reasons why people think as they do, but part of it has to stem from a lack of understanding of how hazards can affect all of us if not dealt with in an appropriate and timely manner. Moreover, in this world of "what's in it for me," there is often a lack of incentive to act.

Accepting one's liability, real estate disclosure, insurance programs, and financing restrictions are few of the ways to encourage mitigation activities.

Liability

Local governments have a responsibility to protect the public from natural and technological hazards. With that comes a degree of liability. Communities have several tools and options available to reduce the potential for hazard-related liability (International City Management Association, 1991). Armed with a comprehensive hazard identification vulnerability analysis and detailed maps of local hazards, a community can control actions that may create or exacerbate hazards through zoning, building or other special codes, and careful evaluation of permit applications.

When use is permitted in a hazard area (e.g., a landslide, or liquefaction area), a disclaimer of public liability creates awareness and reduces potential liability suits. It may also provide an incentive for the user not to proceed.

Policies should be openly debated. By including local and regional planning, environmental interest groups, chambers of commerce, elected officials, and businesses and people at risk, emergency managers can promote hazard mitigation and increase the chances of securing a strong and effective mitigation policy. All hazard mitigation measures, including permit approvals and denials, should be based upon adequate data that is equitably enforced.

Disclosure

With homes averaging $100,000 to $750,000 in some communities, disaster costs can accumulate quickly.

Real estate disclosures can have a positive effect on hazard mitigation. Full disclosure could provide an element of hazard education allowing the consumer to make informed decisions on acquisition. However, to be effective, real estate disclosures need to provide a detailed description of the hazard and associated risk. For example, merely, stating the property is in an earthquake

zone does not adequately describe the hazard. The property could be located in a liquefaction zone, thus increasing its risk to catastrophic earthquake damage, or it could be on bedrock where damage is likely to be minimal. The decision to buy or not buy, or even to buy and mitigate the possible effects of the hazard, depend on the quality and quantity of information disclosed. Disclosures should apply to leased and rented property as well property for sale, and include all historical hazard occurrences on the property.

When there is a full real estate disclosure, a consumer may see the benefits of elevating their home to prevent future flood damage, or securing their foundation to prevent earthquake damage. Business owners may see the value of using flood proofing techniques in accordance with local land use planning, zoning, and building codes. And, communities may decide that buying out repetitively damaged structures or relocating them instead of assuming the cost of reconstruction, is a better alternative

Insurance

The insurance industry has been unable to fully implement an incentive program in Washington State. However, significant progress is being made at the national level with the Institute for Business and Home Safety (previously, the Institute of Property Loss Reduction). Insurance should be emphasized as an effective and invaluable mitigation tool whether for personal or business purposes.

Many homeowners are unaware that their homeowner insurance policy does not cover earthquakes, landslides, flooding, etc. The first step in making insurance an effective mitigation strategy is educating the consumer. One effective method of doing this is to have the insurance agent counsel clients on the local hazards and explain to them what is and is not insured if losses occur during various disasters. When a client declines coverage, the agent should have them sign a statement of declination. This tends to add seriousness to the transaction and gives the agent a measure of protection from future liability.

For homes and facilities in floodplains, the National Flood Insurance Program can provide coverage. Additionally, preferred risk policies are available for those outside the designated areas.

For earthquakes, a special policy or rider is required. It is estimated that only five-percent of homes in the Puget Sound region (Olympia to Seattle) have earthquake insurance policies or riders. In California, the coverage is closer to 20 percent. Earthquake insurance for business and industry insurance may be costly; however, the alternative may be even more so. A great deal of commerce is concentrated in high population areas, which also happens to be where earthquake faults are located.

Specific riders or policies are also required for landslides or earth movement. The term “earth movement” generally includes landslides caused by rain runoff, snowmelt, or flooding, as well as earthquakes. A 1999 landslide in Kelso, Washington affected 137 homes. None of the homeowners had purchased landslide insurance. The losses were in the millions. Homeowners will get some disaster assistance but it will amount to only pennies on the dollar.

“Individual property owners often do not understand the importance of fire protection measures. Without incentives, property owners may not voluntarily implement measures”(DCD & DNR, 1994, p. 11). Currently, there are few direct incentives for individuals or communities to reduce the impact of wildfires. Insurance rates, building limitations, and use factors are independent and generally do not promote or recognize the need for wildfire safety. Having the proper type fire resistant roof and clearance around a structure can reduce losses by eighty-five percent.

Insurance rate structures and eligibility of risk for homeowners' insurance varies among private insurers. Some insurers do not provide homeowners' coverage in unprotected locations. Deluxe homeowner policies may not be available through some insurers in Protection Class 9 and above. Insurance rates increase as Protection Class ratings increase. Some insurers consider the type of construction and materials. One factor not currently considered in homeowner ratemaking is site specific information relating to vegetation clearance and exterior hazards. Homeowners might possibly be enticed to mitigate the wildfire hazard if insurance companies would:

1. Provide incentives for those who live and build in a fire safe manner within the wildland-urban interface area.
2. Require those who create an additional hazard within the wildland-urban interface area to bear a larger portion of the cost.

The Washington State Insurance Commissioner's Office offers assistance for insurance questions or complaints by calling (800) 562-6900 (Washington State Insurance Commissioner. 1997).

Along with the insurance industry, the banking community bears the financial brunt of destruction following a disaster. It is in their best interest to ensure that loans are not subject to high risk and that proper construction standards are followed. One method of doing this is by refusing to make loans for construction in known hazardous areas, or insisting that measures be taken to reduce or eliminate the risk as a condition of the loan.

Recommendations

High Priority Recommendations

Recommendation 6-1
Record high water marks immediately following a record flood, especially when there has been significant development or changes in the area. High water marks will help determine the need for flood map revision or the need to take other measures.

Recommended Lead Agency(ies): Ecology and FEMA. Prerogative of local jurisdictions

Medium Priority Recommendations

Recommendation 6-2
Discuss site specific mitigation measures that have a potential for future damage to determine whether federal or state assistance could be denied due to a "preexisting condition," and to determine liability/responsibility for these projects.

Recommended Lead Agency(ies): EMD, WSDOT, Ecology, and FEMA.

Recommendation 6-3
Consider providing local governments, that have adopted a comprehensive flood control management plan or have accepted the Growth Management Plan, with a streamlined process to obtain priority loans, grants, and/or permits for emergency repairs. The process should also address the continuation of work beyond the emergency period to compensate for habitat windows and other regulatory or resource constraints.

Recommended Lead Agency(ies): Ecology, DCTED, EMD, WSDOT, Fish and Wildlife, DNR.

Recommendation 6-4
Develop a model local relocation program for property and structures in imminent peril. Solicit voluntary relocation of structures in imminent threat from landslides to non-hazardous areas whenever it is cost effective and there is sufficient time. Include a means for those relocating to obtain the necessary permits from regulatory agencies in an expedited manner. This program should also address the expeditious connection of utilities and services at the

receiving sites, as well as the disposition of damaged structures, utilities, and infrastructure.

Recommended Lead Agency(ies): EMD and FEMA.

Recommendation 6-5
The insurance industry should encourage proper building or infrastructure maintenance, creating defensible space (fire) around homes, retrofitting, or other measures which prevent or lessen the effects of a hazard, as incentives for lowering insurance rates.

Recommended Lead Agency(ies): Office of the Insurance Commissioner (OIC).

Recommendation 6-6
Encourage insurance companies to recognize the impact of a safe fire environment and give financial incentives to those that cooperate and increase premiums to those who add to the fire problem (DCD & DNR, 1994, p. 11).

Recommended Lead Agency(ies): OIC and DNR with support from homeowners, insurance agencies, and developers.

Recommendation 6-7
Provide objective criteria and other assistance to identify hazard levels to insurance companies, and the public, such as hazard maps; home construction materials; defensible space and adequate access.

Recommended Lead Agency(ies): OIC and DNR with support from homeowners, insurance agencies, and developers.

Recommendation 6-8
Perform an analysis that clearly shows the economic and social cost of disaster compared to the cost of mitigating that disaster. Many communities in the United States have documented their losses from earthquake, hurricanes, and other disasters. Use this information to educate private sector and government organizations on the state's economic vulnerability, especially when faced with a major earthquake that can trigger a cascade of disastrous events. Use this information to as starting point for selling mitigation strategies that preclude these losses. Because a study of this nature will be a major undertaking, the Legislature may have to provide special funding.

Recommended Lead Agency(ies): EMD, DNR, FEMA, Cascade Regional Earthquake Workgroup (CREW), ASCE Geotechnical Section and the Structural Engineers Association of Washington.

Recommendation 6-9
Promote appropriate hazard insurance as means of mitigating the economic affects of hazards. Insurance is the only means of substantially reducing the economic impact of disaster.

Recommended Lead Agency(ies): OIC and insurance agencies. Prerogative of businesses, citizens, and government.

Low Priority Recommendations

Recommendation 6-10
Develop a model local acquisition program for property and structures in imminent peril. Assist communities in pursuing voluntary public acquisition of property and structures in landslide hazard areas whenever it is cost effective and reasonable. Although this program is may not be used often due to high property values and desirability for bluff property, it will allow the property owners and the local jurisdictions another alternative method for landslide hazard mitigation.

Recommended Lead Agency(ies): EMD and FEMA.

Recommendation 6-11
A state agency should be appointed to track all disaster costs of state and local agencies for use

in obtaining federal and state disaster or other program reimbursement. A standard needs to be set for what is collected so that the state's overall economic impact can be accurately tracked for each occurrence.

Recommended Lead Agency(ies): Office of Financial Management (OFM).

Recommendation 6-12
When developing comprehensive land use plans, include zone specific regulations for high-risk fire areas and substantial wildland/urban interface zones. Support the plan with local ordinances. The plan could require homes within a high hazard area to meet safe driveway entrance/egress standards for fire trucks. Driveway access, roofing material, landscaping, and vent screening should be included. Clark, Skagit, Kittitas, and Yakima Counties have actively pursued this concept. These zone specific regulations should be encouraged in all counties with ongoing wildland/urban interface fire hazards (Tridata Corporation, 1998). This action should be considered as an incentive for lower insurance rates.

Recommended Lead Agency(ies): DNR.

Recommendation 6-13
Use news releases and insurance agency promotions to encourage the acquisition of insurance for currently uninsured farm and out buildings.

Recommended Lead Agency(ies): OIC and insurance agents.

Recommendation 6-14
Identify various types of insurance incentives that would promote hazard mitigation measure as a means of reducing future damage and costs due to disaster.

Recommended Lead Agency(ies): OIC and insurance agencies.

Issue 7

While warning systems in the state have improved in recent years, there is still a need to educate the public on the terminology used and its meaning; improve river and stream flood gauges so that more accurate predictions of flooding can be made; and improve the reliability of warning equipment, especially tsunami warning systems for near shore earthquakes, and lahar warning systems for people in the inundation zones around the state's five volcanic peaks.

Discussion

Public awareness of warning systems is critical. Varieties of warning systems have been instituted over the past few years, both nationally and within the state. Weather information can help in formulating decisions that enhance public safety

Weather Warning Terminology

Knowledge of weather terms such as "Watch" and "Warning" have not been well understood in the past, and when they have been understood, they have been ignored leading to an increased risk to public safety. For example, on January 19, 1993, the National Weather Service (NWS) picked up an atmospheric low-pressure area moving toward the Washington State coastline. A "High Wind Watch" with advisories to take precautionary measures was issued. As the storm developed, the "Watch" was upgraded to a "High Wind Warning," which triggered automatic transmission, via law enforcement Teletype and the National Warning System (NAWAS), to all county and municipal public safety agencies. The media did not broadcast this information, as it normally would have, perhaps because of the ongoing Presidential Inauguration coverage. The storm turned out to be very destructive and seemed to catch many by surprise.

Part of the problem stemmed from confusion over terminology. Windstorms with the intensity of the Inauguration Day Storm (50-100 mph) occurs decades or more apart. The National Weather Service uses "High Wind Warnings" to announce these large storms. They use the same warning for storms of much less force (>40 mph), which occur almost annually. This presented some confusion as to the seriousness of the 19 January event. Consequently, many found themselves caught and at risk in the middle of the windstorm. Local, state and federal government agencies closed down and let employees go home in the middle of the storm, as did most schools. Childcare centers called parents to come pick up their children at the peak of the storm. Children released from school were sent home without consideration for the imminent danger of the winds, falling trees, and downed power lines.

Efforts to raise awareness of the National Weather Service's existing watch and warning terminology have since increased. The National Weather Service and the state emergency operations center use a mutually agreed upon set of meteorological terms (see appendix A). In addition, there is an ongoing effort to educate the public on warning terminology and appropriate protective measures. Efforts in this area include the distribution of pamphlets or brochures as well as conducting meetings and seminars for public agencies and the media.

The media, especially the local news, has become more proactive, including on-site reporting to visually show the hazards. They also use of "trailers" during broadcasts to keep the information current. This helps in clarifying the intensity of the event.

Forecast and Warning Tools

The installation of Doppler radar systems has enhanced the accuracy of forecasts, providing more time for the local jurisdictions and its citizens to get prepared. Along with outreach efforts to educate the public on weather terminology, the new forecast and warning tools have improved, particularly since 1993.

Active warning systems like the National Oceanic and Atmospheric Administration (NOAA) tone alert weather radios, and the Emergency Alert System (EAS), which replaced the Emergency Broadcast System (EBS), are now available to all broadcast media (AM/FM radio, TV, cable TV). In addition to these systems, the Emergency Managers' Weather Information Network (EMWIN) can reach the public directly with weather warning information, providing an alert to impending hazards.

The Washington State Grange, in cooperation with the National Weather Service and the Washington Military Department, Emergency Management Division, distributed the NOAA tone alert weather radio to public and private agencies with vulnerable populations. In case of a severe weather warning or other disaster, these radios self activate, warning the owner of a potentially dangerous situation. School district offices received radios in 1995; hospitals and nursing homes during 1996-97. In 1997, new broadcast locations were established to improve broadcast coverage.

A proposal was made in the summer of 1999 to expand the broadcast reach of the system to cover every segment of the state. When this happens, the tone alert radio can be used as a single all-hazard warning system for the entire state. Slightly over one million dollars is needed to expand the existing network to cover the state.

The Internet is another means to receive warning information. Additionally, the United States Geologic Survey (USGS) has real time monitoring available on the World Wide Web. However, the Internet is considered a passive warning system since it does not directly inform when a warning message is received.

In order to develop more effective weather warnings, the policies governing the use of the Emergency Alert System are continually reviewed and evaluated. As of July 1997, the National Weather Service centers in Portland, Pendleton, Spokane, and Seattle can originate EAS alerts for broadcasters with encode-decode devices to automatically rebroadcast the alerts.

Warning local communities about existing landslides and avalanches can also provide a tool for educating the public. This may be done through road signs, public meetings, or the media.

Warning systems are also in place in applicable counties in Oregon and Washington to warn the public of chemical leaks at the Umatilla Army Depot in Umatilla, Oregon.

The Washington Military Department, Emergency Management Division, Telecommunications Section continually evaluates and revises warning systems and procedures used to distribute warning information to state, local, and federal agencies, the media, and citizens.

Situation Alerting (DCD & DNR, 1994, p. 21)

Interagency notification of all pertinent information does not always occur before and during incidents. For example, fire situation reports are available from the lead wildland fire agency managing the incident; fire weather information is available from the National Weather Service and wildland fire agencies in Wenatchee and Olympia in Washington, and Pendleton and Salem in Oregon.

The National Weather Service provides fire weather and situation alerting through their Internet homepage. This ensures that adequate fire and special weather information is available to everyone with a need to know. In addition, two NOAA weather radio transmitters were set up in central Washington in support of the Chemical Stockpile Emergency Preparedness Program. This system can be used to warn the public of all-hazards in the listening area.

Tsunami Warning

In an effort to increase preparedness along the Washington coast, the Washington Department of Transportation, in cooperation with the Washington Military Department, Emergency Management Division, installed tsunami hazard and evacuation signs during the summer of 1997. The tsunami hazard signage uses the same design as programs in Alaska, California, Hawaii, and Oregon. Coastal communities also distribute tsunami hazard brochures to tourist and public facilities along the coast.

Additionally, the National Oceanic and Atmospheric Administration deployed a real-time tsunami detection buoy system approximately 140 miles west of Newport, Oregon. This system includes a bottom pressure recorder that can measure tsunami wave amplitudes of less than one centimeter in the deep ocean, and a surface buoy that sends the wave data to shore stations via satellite (Staff, 1997, p. 1). Because it provides a timely warning with a much reduced false alarm rate, this new system should increase accuracy as well as the public's trust in the warnings. This is critical considering the coastal areas subject to tsunami in Washington are lowlands with few evacuation options.

However, vulnerability, accuracy of forecasts, evacuation, local warning capability, and public education remain issues. Locally generated tsunamis from coastal earthquakes might only allow minutes for warning and evacuation before tsunami waves began to inundate coastal areas. Inundation mapping, evacuation, and hazardous materials storage plans are still needed.

Gages

Most major rivers have telemetry gage stations that are used to monitor flood levels allowing for timely forecast warnings. Most urban streams do not have gages or adequate numbers of gages to permit the forecasting of urban watershed flooding. Since many of these basins reach flood stage quickly, there is a need for more gauging equipment.

Some communities forecast urban flood warnings through the coordination of real time National Weather Service Doppler weather radio information and Urban Stream Stewards. Television stations have a network of mini-weather stations at schools throughout most of Western Washington although these are not necessarily coordinated with on-site neighborhood urban stream monitors. Funding for warning systems and maintenance is generally not available.

In addition to the gages for rivers and streams, there are gages for snow pack (Sno-Tel). These gages provide information regarding depth and can assist in calculating water storage or problems for flooding in case of an early warming trend, and the future possibility of drought.

Lahar Warning

Volcanic mudflows or lahars may be triggered by rapid release of meltwaters during an eruptive phase. Lahars are the result of massive landslides formed by collapse of unstable, hydrothermally altered water and clay-rich rock. Detecting an approaching lahar and issuing an automatic notification that would trigger a rapid, preplanned evacuation of the inundation zone, would reduce risk. Such a detection and warning system has been developed and is in place for people living in the Orting Valley providing an element of protection from a Mt. Rainier Lahar. Several Mount Rainier lahar mitigation strategies have been suggested in "Lahar Detection at Mount Rainier: A framework for Decision" (U.S. Geological Survey, 1997)

Recommendations

High Priority Recommendations

Recommendation 7-1
Determine current rain and stream gage capabilities of local, state, and federal agencies in flood-prone areas. Identify additional locations in river basins, urban streams, and watersheds, subject to frequent flooding, where gages are needed to improve forecast and warning capabilities. Identify funding source(s) for installation, monitoring, and maintenance.

Recommended Lead Agency(ies): Ecology with the National Weather Service (NWS), USGS, USAG-NRCS, and USACE. Prerogative of local jurisdictions.

Medium Priority Recommendations

Recommendation 7-2
Weather forecasting capability has been improved with the installation of Doppler radar across the state. Explore the installation of more reporting stations or other means of expanded weather reporting and data collection. Revise and update the present weather forecast computer model.

Recommended Lead Agency(ies): National Weather Service.

Recommendation 7-3
Investigate the practicality of integrating the monitoring of potentially unstable slopes into a public warning system. Such a warning system may include automatic sensors in landslide susceptible areas with linkages to communication systems, groundwater monitoring, avalanche wires, or slope indicators, depending on the circumstances of the site and the capabilities of the system.

Recommended Lead Agency(ies): Ecology. Prerogative of local jurisdictions.

Issue 8

While there are a number of coordinated state level plans that deal with hazard mitigation, local plans and strategies are nearly nonexistent.

Discussion

A variety of agencies administer planning requirements as well as design and construction standards. Local government resources are adversely impacted by redundant planning requirements when these requirements and standards are not coordinated. Failure to coordinate also reduces the chance that plans and standards will be carried out to the fullest potential.

State owned facilities or leased facilities in flood-prone areas have standards that are compatible with local plans and regulations for siting facilities in communities. The Department of General Administration developed a state flood mitigation standard for location, construction, and siting of facilities on state-owned or leased properties in flood prone areas. These standards ensure compatibility with local comprehensive plans, regulations, and growth management regulations.

The Growth Management Act requires many local jurisdictions to develop comprehensive plans. These plans, along with other planning requirements related to flood hazard reduction share common elements. Coordination of planning requirements ensures that plans that meet one requirement will have progressed toward meeting other requirements. In addition, jurisdictions will likely find that plans for one purpose offer additional benefits.

The Department of Community, Trade, and Economic Development (DCTED) reviews comprehensive plans prepared by local governments under the Growth Management Act. Taking note of critical areas, CTED works with the Washington Military Department, Emergency Management Division, to advise local governments of opportunities to reduce the risk of, and/or their vulnerability to, flooding and other natural hazards. CTED also will review other documents submitted by local governments, such as Environmental Impact Statements, for the same purpose.

The Department of Community, Trade, and Economic Development, Growth Management Services, using a Hazard Mitigation Grant, developed a brochure regarding an “optional chapter” and a model ordinance element on critical areas for natural disasters. This includes areas that are frequently flooded, or prone to landslides and wildfire. Growth Management Services conducts workshops on how to develop the new chapter, emphasizing hazard mitigation planning and the Community Rating System. Coordination of plans often needs to extend beyond the local boundaries and include bordering districts, cities, counties, or even countries. A number of state agency plans and procedures have done this. For example:

- A 1995 Memorandum of Agreement, “Coordinating Flood Planning in Washington State,” signed by the Department of Community, Trade, and Economic Development and the Department of Ecology, defines an integrated approach for developing local flood hazard management/ mitigation plans in Washington State. The agreement emphasizes the development of a single flood mitigation plan at the local level, and ensures that such a plan, when approved, will meet state and federal requirements for a variety of project funds.

- The Washington Military Department, Emergency Management Division and the

Seismic Safety Advisory Committee developed *A Policy Plan for Improving Earthquake Safety in Washington, Fulfilling Our Responsibility*, December 1, 1991.

- The Department of Ecology developed *Comprehensive Planning for Flood Hazard Management*, August 1991.

- The Department of Ecology chaired the Water Supply Availability Committee and led the development of the *Drought Contingency Plan*, January 1992, Annex Z2 to the 1985 Washington State *Comprehensive Emergency Management Plan*. Recommendations were made to the Executive Water Emergency Committee and Special Task Forces, chaired by the Governor's Office. Legislation was passed for implementing mitigation measures.

- The Washington State Legislature created a temporary Joint Select Committee on Flood Damage Reduction. This committee reported findings to the 1993 Legislature related to the 1993 state *Flood Damage Reduction Plan*, which resulted in recommendations for state agency regulation and policy changes.

- The Washington Military Department, Emergency Management Division, developed the *Flood Damage Reduction Plan*, 1996.

- The Department of Community Development, Emergency Management Division in coordination with the Department of Natural Resources and Washington Wildfire Mitigation Committee, developed the *Washington Wildfire Mitigation Plan*, May 1994.

- The Washington Military Department, Emergency Management Division, developed the *Washington State Wind Mitigation and Action Report*, May 1994.

- The Washington Military Department, Emergency Management Division, conducted a survey of local emergency management departments in November 1996 to determine what environmental and hazard mitigation planning or analyses existed in each jurisdiction. Fifteen counties and nine cities responded. Of the respondents, 15 had reviewed the jurisdiction's hazard vulnerability during the 1990's and 22 had either a growth management plan, a comprehensive flood management plan, or had developed an all hazard mitigation plan or strategy.

- The Department of Ecology successfully obtained five million dollars for planning and flood hazard reduction projects during the 1996 legislative session. This was in addition to the state matching funds made available for the Hazard Mitigation Grant Program and Public Assistance Program, both administered by the Washington Military Department, Emergency Management Division.

- The Department of Ecology developed a Guide for Dam Safety. This includes emergency operational procedures.

- The Department of Information Systems developed a plan and training for disaster recovery of computer back ups and records, including a site out of state.

- In September 1998 a "Comprehensive All Hazard Planning Guide and Model School Program for Washington State Schools" was jointly developed by Kitsap County and the Washington State Emergency Management Division and subsequently approved by the Superintendent of Public Instruction. The plan is available to every school in the state. Training courses and workshops aimed at assisting schools in developing comprehensive plans, using this guide, are

available through Washington State Emergency Management.

Recommendations

High Priority Recommendations

Recommendation 8-1
Develop local hazard reduction plans/strategies.

Recommended Lead Agency(ies): EMD

Recommendation 8-2
Develop and maintain a list of approved comprehensive flood management plans. Consider posting this list on the Internet.

Recommended Lead Agency(ies): Ecology.

Recommendation 8-3
Develop a training program for local jurisdiction officials that explains the value of mitigation planning and shows them how to implement the process.

Recommended Lead Agency(ies): EMD.

Recommendation 8-4
Develop a mitigation campaign strategy aimed at raising the interest level of local government officials in the mitigation process.
Recommended Lead Agency(ies): EMD.

Recommendation 8-5
Develop a hazard mitigation-planning workbook for use in developing local mitigation plans.

Recommended Lead Agency(ies): EMD.

Issue 9

Communication systems often lack redundancy and interagency/governmental operability preventing essential communication during and immediately following a disaster.

Discussion

During emergencies, when normal telephone communications are down, local governments and public safety agencies at all levels may be left with only a few cellular telephones with which to respond. Cellular telephone use is limited by several factors. First, the telephone numbers of most cellular telephones are not widely known by those that may need assistance. Second, most calls from or to cellular telephones use landline connections at some point, and third, when the regular telephone system is not working the cellular networks will likely be overloaded and not reliable. During the 1996-97 winter storms, Eastern Washington communities found the use of cellular telephones and portable radios to be critical during utility restoration as well as search and rescue missions.

The Federal Communications Commission has recognized the cellular overload problem, especially during emergency events. If operational priorities are not established and given to emergency management organizations before disaster strikes, the cellular system will be of little or no value to during the initial response.

Satellite cellular telephone and amateur radio can be used to provide system redundancy or even primary capability. Cross-band repeaters strategically placed or deployable, could be used to facilitate interoperability of the different radio frequencies.

Incident communication is invariably a problem and can become virtually insurmountable when mobilized resources are drawn from across the state. This can affect operational effectiveness, and safety. Wildland agencies (federal and State Department of Natural Resources) are buying "migratable" radios, which can be programmed to operate on either analog or digital radio systems. When digital capability is in place, system-wide compatibility may occur.

"No agency coordinates radio communications among all governmental and private entities. When fire services leave their local area, a common communications capability and/or system does not usually exist where an incident occurs. Private entities also do not share a common communication network at the local level when they are involved with the management of an incident. New communications technology is, or will be, utilized by some entities and not others, further widening the capability gap (Washington Wildfire Mitigation Plan, May 94)."

For fire fighting purposes an integrated communications plan/capability involving the Department of Natural Resources, Washington State Patrol, and the local fire services needs to be developed and implemented. It may be desirable to have a local/regional communications plan with the identification of communications resources (Washington State Fire Defense Board, 1997).

The Washington Military Department, Emergency Management Division, in coordination with other state agencies, developed, the Washington State *Emergency Communications Assessment of Capabilities* in November 1993. The committee made four recommendations that resulted in:

1. A limited number of transportable satellite telephones have been pre-positioned throughout the state to provide contingency emergency communications. The State EOC also has satellite telephones in-place. It is still Emergency Management's goal to place a satellite telephone in each jurisdiction to support alert notification and direction and control during emergencies. Satellite telephones have proven to be invaluable in areas inaccessible by radio or cellular telephones. For contingency purposes, some state agencies are obtaining satellite telephones and placing them in respective regional or district offices.

2. The 800 MHz state agency emergency radio system has been in-place since 1997 through use of an additional 800 MHz repeater installed at Capitol Peak on the WSDOT 800 MHz radio system. To date, eight state agencies have obtained appropriate 800 MHz radio equipment. Other agencies are considering participation in the system soon. The system is tested twice per month.

3. As of October 1994, the state Emergency Operations Center is staffed 24-hours a day, seven days a week.

4. Alternate EOC locations have been identified, but specific facilities and detailed equipment/system needs still need to be determined.

Some school officials were unaware of the extensive damage caused during the Inauguration Day windstorm of 1993. Inoperable telephones, inadequate emergency procedures, and failure to communicate with local emergency management officials resulted in sometimes poor and dangerous decisions involving both students and faculty. NOAA tone alert weather radios are now in every school district.

Recommendations

High Priority Recommendations

Recommendation 9-1
Schools should consider developing prepared

messages for distribution to selected media in times of inclement weather and emergencies. Identify if alternative communications, such as radios are available. Make sure emergency plans and procedures are well known throughout the community.

Recommended Lead Agency(ies): Office of the Superintendent of Public Instruction (OSPI) in coordination with local school districts and local emergency management departments.

Issue 10

Critical facility identification and protection is lacking in many communities, as is the need to identify and protect essential lifelines.

Discussion

Critical Facilities

Natural hazards, including landslides and floods, have potentially devastating effects on critical facilities and infrastructure like utilities, telephone, electrical power, pipelines, railroads, highways, ports, bridges, reservoir sites, and wastewater facilities. The emergency may be compounded by on-site or nearby toxic or hazardous materials and affect emergency services, police, and fire.

Many older firehouses and hospitals are vulnerable to earthquake. Only a few of the water and wastewater utilities have assessed seismic vulnerability. Electric utilities have done some vulnerability assessments. The natural gas companies in Washington have done limited work to address seismic safety (DCD, 1991).

Lifelines

Maintenance of Right-of-Ways. Large evergreen and deciduous trees symbolize the quality of the environment people enjoy and protect in the Pacific Northwest. However, these trees also make above-ground utility lines and roadways more vulnerable to damage from falling trees as a result of strong winds, heavy ice or snow, landslides, saturated grounds, or floods. Not all communities and utilities have vegetation management plans and maintenance programs and only some of the plans address high-risk areas and threatening trees. Proper maintenance of electric utility right-of-ways (ROWs) plays an important role in reducing the risk. There is an effort to maintain a balance between the desires of property owners to limit tree trimming/ removal, with efforts of electric utilities to maintain reasonable separation between power lines and trees (DCD & DNR, 1994). Budget, citizen participation, and other factors determine the effectiveness of vegetation management.

Some utilities retain a forester to guide management of vegetation around utility line rights-of-way. The forester may offer advice on trimming, removal, and/or replacement of threatening trees in the right-of-way or on adjoining private property (with permission of the property owner). Planting the appropriate vegetation for subdivisions or business complexes is critical. Developments can use trees and urban friendly vegetation to assist in controlling wind and flood damage.

When developers leave greenbelts consisting of small strips of unprotected, tall, sacrificial trees, there is an additional risk to utilities and homes. When too many trees are removed, they are no longer able to provide mutual support to one another. The remaining trees are structurally unstable in high winds or other stressed conditions.

Downed trees, limbs, and other vegetation often litter the state's roads and utility rights of way following storms. In extremely wet and/or cold periods, like that which occurred between November 1995 and June 1996, the ground becomes saturated from weeks of runoff, roots become loose, frozen limbs crack, and trees, lacking the necessary support system, fall over.

Normally, wind gusts of over 50 mph are needed to topple certain trees, but when the ground is very wet, wind forces as low as 15-to-35 mph topple trees (Washington Water Power, 1997).

De-energizing Power Lines. "De-energizing power lines during emergencies (like a severe windstorm or volcanic ash eruption) may reduce the number of fires. However, de-energizing lines will increase the public's risk in other areas. For example, a lack of electricity will:

1. Limit traffic control capabilities. This could lead to vehicle accidents and will reduce response rate of emergency vehicles.
2. Limit availability of water supplies to many rural fire districts.
3. Prevent homeowners from operating wells, thereby limiting their ability to protect their homes from fires.
4. Interrupt many vital communication systems.
5. Cause other incidental property damage such as food spoilage" (DCD & DNR, 1994, p. 13).

Use of Underground Cable. There are many issues involved in determining when the use of underground cable is in the public and ratepayer's best interests. "Underground cable has certain advantages and disadvantages; a few are summarized below:

Advantages -

1. May prevent conditions causing certain types of fires such as tree-downed power lines.
2. Is generally more aesthetic than overhead lines.

Disadvantages -

1. Can pose additional safety hazard. Accidental exposure to cable can occur when public/contractors dig near lines. Failure of, or damage to, ground mounted equipment (transformers) can lead to fires.
2. The time required to locate and repair cable failures is generally longer.
3. Rock and excavation problems limit where underground cable can be economically installed.
4. It is generally inappropriate for transmission lines (high voltage lines used to transmit power between areas)" (DCD & DNR, 1994, p. 14)."

Prolonged Power Outage. When a series of storms affect the state, like the ones during the winter of 1996-97, when rain, ice and wind combined in back-to-back events, we can expect to see repeated utility damage accompanied by prolonged power outages.

When extreme cold weather and power outages occur simultaneously, propane gas supplies, transportation systems (highways, bridges, and ferry), home heating, storage of refrigerated foods, and treatment for and access to sewage and water supply systems may be affected. The availability of fuel and water is periodically disrupted due to the loss of pumping capability. Without power, frozen pipes and structural damage occur. These situations are exacerbated by insufficient back-up power systems, including generators.

Back up power systems are necessary to provide vital services, especially to vulnerable populations. However, proper installation, use, and safety are prime concerns.

Licensed nursing homes (RCW 18.51) have been required to have emergency generators since 1981. However, facilities in existence before 1981 that have not been significantly remodeled may not have a back-up power source. According to chapter 388-97-315 WAC, nursing homes are required to have an alternate source of power and automatic transfer equipment to connect the alternate source within ten seconds of the failure which must be capable of providing power for a minimum of four hours. This limited mandatory back-up requirement allows time for evacuating residents to an appropriate shelter.

Washington Administrative Code Title 51 specifies emergency power requirements for boarding home occupancy, fire, and emergency alarms with telephone and voice messaging,

hazardous exhaust ventilation, gas detection, and temperature controls. WAC Chapter 246-316 defines emergency power requirements for life support equipment and lighting in boarding homes and WAC chapter 246-318 covers hospital requirements.

Local emergency management departments should have limited 24-hour power capability, especially for gathering meteorological data and warning capabilities in accordance with emergency management planning standards.

Adequate Water Supply. Water supply and location are critical factors in fighting all types of fires. In older residential areas or smaller rural communities, growth may have surpassed the capability of the water systems. This area needs to be addressed during the review process of building development or as an annual assessment of local capacity. The *State Fire Services Resource Mobilization Plan* provides for moving water in water tenders for fire fighting when necessary.

Recommendations

High Priority Recommendations

Recommendation 10-1
Inventory school buildings as to their risk, by district. The inventory should include the building age, number of students housed, and other risk factors. This survey should address maintenance and repair requirements as well as training on seismic safety issues, accessibility, and liability.

Recommended Lead Agency(ies): OSPI.

Recommendation 10-2
Prolonged Power Outage. Develop an inventory of critical facilities that must have electrical power during power outages. The inventory should include electrical power generation requirements/capacity. It should also state whether the site is suitable for use as a shelter (kitchen, a serving area, rest rooms, and heated sleeping area(s).

Lead Agencies: Department of Labor and Industries (L&I), Department of Health (DOH), OSPI, and school districts, CTED, Development, Department of Social and Health Services (DSHS), and public and private utilities. Prerogative of local community and emergency management departments,

Recommendation 10-3
Research current, statewide requirements and the possibility of legislation that would require back-up electrical power in emergency and critical facilities such as police, fire, school, water and waste water treatment facilities, and health care facilities. Most nursing homes have a limited back-up power supply.

Recommended Lead Agency(ies): DOH.

Recommendation 10-4
Determine if the local Growth Management Act and site zoning take rights-of-way and corridors into consideration for development in areas containing natural gas pipelines.

Recommended Lead Agency(ies): DCTED-Energy Facility Site Evaluation Council, and WUTC.

Medium Priority Recommendations

Recommendation 10-5
Establish a definition of critical facilities. Among the public support facilities to consider are police, fire, school, emergency operation centers, public buildings used for shelters, water and wastewater treatment, and health and critical care facilities like hospitals. Fuel, utilities, or other suppliers should be considered, as well.

Recommended Lead Agency(ies): DOH, Health Care Authority, OSPI, DSHS, local emergency management departments, public and private

utilities, school districts, and volunteer organizations.

Recommendation 10-6
Provide a "designed-failure" point into power lines whenever possible so that failures are more likely to occur at predetermined locations. This could permit easier and safer repairs while minimizing the affected areas.

Recommended Lead Agency(ies): WUTC and public and private utility companies.

Recommendation 10-7
Inventory and perform a risk assessment of all buildings and critical facilities. This will facilitate an economic loss estimate as well as mitigation planning and decisions regarding retrofit, and replacement. The inventory should include building locations, construction type, age of building, occupancy and use, and site conditions. This will assist in identifying priorities for seismic, flood or other hazard risk.

Recommended Lead Agency(ies): All state agencies. Prerogative of local communities.

Low Priority Recommendations

Recommendation 10-8
Prepare standards for back-up power, including installation, operation, and maintenance of typical units and select one or more critical facilities for installation of a back-up generator for demonstration and training.

Lead Agencies: DOH, OSPI, CTED, DSHS, school districts, and public and private utilities.

Recommendation 10-9
Provide for removal of "harvest trees" in areas vulnerable to summer fire storms and limit the potential spread of bark beetles.

Recommended Lead Agency(ies): DNR, Parks and Recreation Commission, local public works departments, public and private utility companies, and private citizens.

Recommendation 10-10
"Develop and promote education programs emphasizing importance of cooperation between property owners and utilities. Program objectives are to:

a. Stress to property owners the importance of working in cooperation with utilities as they cut trees or plant trees near power lines.
b. Encourage property owners to report trees that could potentially contact power lines.
c. Have the Department of Natural Resources assist electric utilities with identifying risk trees.
d. Continue comprehensive utility programs to maintain right of ways, especially in extreme and high-risk areas" (DCD & DNR, 1994, p.12)

Recommended Lead Agency(ies): DNR and electric utilities.

Recommendation 10-11
Consider removing tall or potentially hazardous trees, including those that have storm damage weakened limbs or multiple tops, from critical areas, rights-of-way, public paths or parks, and developments. Consider replacing such trees with low-growing trees to lessen the potential for causing a power failure.

Recommended Lead Agency(ies): Parks and Recreation Commission, Interagency Committee for Outdoor Recreation, UTC, WSDOT, and public and private utility companies. Prerogative of local planning and public works departments, developers, and private citizens.

Recommendation 10-12
Coordinate dissemination of appropriate telephone numbers with the call centers in various areas of operation. Washington State has an Underground Utilities Law (RCW 19.122) that requires an excavator to call before digging. All underground facility owners are required to belong to the call center servicing their area of

operation. Logging includes not only crossing a pipeline but also excavation. Pipeline companies and other owners are interested in preventing damage and will respond and surface mark their facilities. Loggers can use the one-number locator service (one-call centers) to notify all underground facility owners by calling two business days before crossing or excavating.

Recommended Lead Agency(ies): WUTC

Issue 11

Additional attention needs to be given to where special needs individuals, especially those with serious medical problems, are housed, and how they cared for in times of disaster. Livestock, pets, and wildlife need to be protected and cared for as well.

Discussion

Special Needs Population

The medically fragile are among the special needs populations that are significantly affected by hazardous conditions. Power failures often result in failure of heating and air conditioning systems as well as one's ability to cook. Road closures affect food or medical service delivery. Controlling the quality of air they breathe can be a major concern for those on oxygen or with breathing difficulties. Local planning efforts need to address the evacuation and relocation of medically fragile individuals to hospitals or other appropriate facilities that can provide food, heat, and power for medical equipment when electrical power is either insufficient or not available. Other special populations may have needs, as well. Individuals without vehicles, tourists, or the homeless may require special treatment and care.

Most of the time, the special needs populations are of limited means. Consequently, a very low level of preparedness is possible. When planning for a disaster, economic factors affecting the population should to be kept in mind.

Health Concerns

Whenever a disaster occurs, there is the potential for a health threat. The state and local departments of health work cooperatively to keep these threats to a minimum. One way of doing this is through health advisories. For example, health advisories can be issued when domestic or drinking water is a concern, when well heads are covered with floodwaters, and when sewage treatment facilities have failed, or during a volcano when ash permeates the air affecting electrical equipment, vehicles and breathing.

In a major disaster scenario, emergency medical and trauma systems are quickly overwhelmed. In the case of mass casualties, state and local departments of health would assist in coordinating services. The Funeral Directors Association is also a good resource during mass casualty situations.

Public Expectations

Many Washington residents desire a rural style of living with the normal level of urban services. However, living away from urban areas necessitates developing a certain degree of independence from public agencies in times of emergency. Services are generally not restored as quickly in rural or residential areas. Everyone should plan and be prepared to be self sufficient for at least three-days following a major emergency or disaster. Local emergency management or the American Red Cross can provide brochures and training in preparedness.

Agriculture, Livestock, and Fish and Wildlife

Agriculture, livestock, and wildlife are at risk during many types of disasters. The lack of irrigation water for crops during a drought can have devastating effects such as crop losses,

reduction in jobs, and the financial failure of long-standing farm operations (Washington State Executive Water Emergency Committee, 1998).

During winter storms, grazing areas are often covered by a build-up of snow and ice on grasses and low-growing vegetation. When icing conditions prevent supplying dry feed by truck or other means, the death rate among unsheltered livestock is high. Hay can be trucked or air-dropped into accessible areas for wildlife, like elk, but it takes time and money to organize these local volunteer efforts.

When windstorms damage trees along streams or waterways, habitat and shading for fish may be lost. Flooding frequently isolates livestock sometimes drowning many farm animals. Elevated and constructed configurations of land, known as critter pads, have successfully prevented many such losses.

Recommendations

Medium Priority Recommendations

Recommendation 11-1
Construct medical facilities in areas free from floods and lahars. Design facilities to meet building standards appropriate for local hazards. Design multiple access routes and plan evacuation scenarios.

Recommended Lead Agency(ies): DOH, DCTED-Growth Management Services, and local building departments.

Recommendation 11-2
Conduct a community forum on saving wildlife and livestock so that volunteer organizations and the state's emergency feed program can better understand how they can work together to mitigate the effects of emergencies or disasters.

Recommended Lead Agency(ies): Department of Fish and Wildlife; local emergency management departments, and private interest groups.

Low Priority Recommendations

Recommendation 11-3
Coordinate public/private efforts to protect and care for wildlife and livestock during emergencies.

Recommended Lead Agency(ies): Departments of Agriculture and Fish and Wildlife. Prerogative of local emergency management.

Issue 12

The enforcement of building codes and standards is negatively impacted by insufficient personnel resources and training.

Discussion

Capabilities of Local Building Departments

Local building departments have the responsibility for enforcing federal, state, and local codes related to building construction projects. However, many times local officials do not have adequate resources or training to properly perform these duties. If codes are not properly enforced, failures are more likely to occur during extreme conditions.

Hazardous Buildings or Homes

One form of public outreach is the "hazard to human occupancy" system of tagging structures used by some local jurisdictions. One system uses color-coded tags (placards). A red tag prohibits occupancy in structures deemed to be hazardous to continued human occupation. Many local jurisdictions have been reluctant to red tag structures due to adverse public reaction. However, red tagging is an essential responsibility of a local jurisdiction's response to hazards like landslides. It benefits property owners, not just as protection from the hazard, but it may also help them obtain low interest loans from the Small Business Administration if

their property is destroyed, damaged, or condemned. This tagging system also includes yellow, which means limited occupancy and green, which indicates the structure is approved for occupancy but there still could be some problems. Other methods of tagging are also used.

Building Codes and Standards

RCW 19.27.050 requires compliance and code enforcement in Washington State. Local officials can set standards based on local conditions that are in addition to the state code.
Building codes are established to ensure uniform minimum standards of health and safety across the United States. A building code requires that a building or facility be located, designed, and constructed so that any threat to the life, health, and welfare of its occupants and the public is minimized or prevented. Building codes are not meant to prevent all damage, but rather to minimize damage.

The State Building Code Council adopted the 1997 Uniform Building Code (UBC), effective July 1, 1998. Recently, publication of the UBC was suspended. The International Conference of Building Officials (ICBO), Building Officials and Code Administrators (BOCA), and Southern Building Code Congress International (SBCCI) merged to form the International Code Conference (ICC). The ICC is developing a family of codes, including building (IBC), fire (IFC), mechanical (IMC) and plumbing (IPC). The IBC was drafted in November 1997 with a target publication date in the year 2000. The State Building Code Council is actively engaged in the development process at the ICC. It is expected that the state of Washington will continue to operate under the UBC for at least the next three years (Tim Nogler, personal communication, January 1998).

In addition to building codes, Presidential Executive Order 12699 imposes regulations on the federal community that enhances earthquake mitigation. Driven by a need to make buildings earthquake resistant, Executive Order 12699 not only affects federal buildings, it also affects federally financed construction and federally insured loans, which make this order a concern to the commercial and residential construction industry as well.

Damage to buildings and subsequent repairs make up one of the largest costs associated with disaster. Since building codes are not retroactive, there is also a continuing need to find ways to bring existing building up to current code specifications in order to improve survivability, public safety and reduce the cost of damage.

Whether the hazard is an earthquake, flood, or wind – these forces can move buildings off foundations or remove a roof. Proper anchoring of walls-to-foundations and roofs-to-walls can prevent damage. Builders must comply with code adoption, and inspections should identify potential fixes.

Snow Load. Since the accumulations of snow on roofs during the 1996-97 winter storms caused a great number of failures, some of which occurred to fairly new construction, it is important to investigate whether or not current local, state and national building codes and standards are adequate to prevent such failures in the future. Actual snow loads may have been higher than the design loads. However, it is not possible to evaluate the adequacy of snow load requirements without knowing what the actual loading conditions on the building were at the time the building failed. The Federal Emergency Management Agency and the Structural Engineers Association of Washington conducted research and performed analysis regarding these 1996-97 winter storms snowload failures. The report is titled An Analysis of Building Structural Failures Due to the Holiday SnowStorms.

Glazing Standards. One issue that occurs in many disasters is the breakage of windows or

other glazed structures, often resulting in injury to individuals. For structures built after January 1, 1994, safety glass or safety glazing material is required for hazardous locations in residential, commercial, industrial, and public buildings to minimize the likelihood of injury to persons. Hazardous locations include windows, doors, shower enclosures, and other areas, as defined in law. Safety glazing can be particularly effective during an earthquake or explosion in preventing sharp-edged shards of glass from hurting people.

Seismic Mitigation. Important issues surrounding the earthquake hazard include building codes, nonstructural mitigation, and what to do with unreinforced masonry (URM) buildings. Should URM buildings be retrofitted, repaired, or replaced? For buildings listed on the historic register, the only choice may be retrofitting. For other buildings, it may be more practical and economical to raze them. Retrofitting and razing have become serious economic issues.

In 1991, an estimated 350-to-400 older unreinforced masonry school buildings containing up to 155,000 children were operational in the state (DCD, 1991). In 1996, the Office of the Superintendent of Public Instruction conducted a voluntary survey. Of the 296 school districts, 202 responded. The survey indicated that 637 buildings, housing 250,000 students, are vulnerable to an earthquake and need retrofitting. Only 1 out of 5 responding districts have completed a seismic study for risk. Nonstructural measures have reduced the hazard in 910 buildings, but over 270,000 students are still vulnerable to existing nonstructural hazards (Washington State Emergency Management Council, Seismic Safety Subcommittee, 1997).

School districts have begun strengthening their buildings for seismic activity as part of their capital improvement programs. The State Board of Education and the Superintendent of Public Instruction reviewed capital funding priorities to begin this process. However, many school facilities still need structural reinforcement.

In addition, school facilities have begun nonstructural hazard mitigation efforts, such as fastening bookcases, filing cabinets, space heaters, and other structures to the wall and ensuring that light fixtures do not fall. The Superintendent of Public Instruction produced and distributed a nonstructural hazard mitigation handbook for schools. Again, much still remains to be accomplished

A United State Geological Survey study found that almost one-third of the state's fire stations were built before 1940, and over three-quarters were built before 1971. This means these facilities are vulnerable to earthquake damage, especially those of unreinforced masonry construction. In spite of this, the study found that 80 percent of the fire service agencies should remain operational. However, the 20 percent reduction in capacity will occur at a time of maximum demand for emergency services. Los Angeles feels that their URM retrofit program worked and that lives were saved during the Northridge event. However, had the event occurred later in the day, falling parapets, facades, and other appendages would probably have killed people. A look at developing a model ordinance for URM buildings may be appropriate.

Reducing the Risks: Ordinances and Zoning

Local building ordinances must be reviewed to ensure one requirement does not give rise to another potentially hazardous situation, such as requiring awnings that cannot withstand wind or snow loads. The storage of hazardous materials continues to be a concern, especially for earthquake or flood events.

Many issues may be resolved through inspections and enforcement of existing codes and standards. However, one must first determine whether or not local codes and

standards are adequate for the area, and if so, that the standards are enforced.

Comprehensive GIS format maps that list liquefaction areas, hazardous material sites, landslide areas, flood zones and other hazards are helpful when reviewing reports for compliance with zoning and ordinance compliance.

Before construction takes place, the consequences of high winds, flooding, earthquake, or other hazards need to be taken into consideration. It is also important to consider how the building will be used. Building that do not house people may not need to meet the same stringent standard as those that do.

Homes in wooded or rural settings are usually designed to meet the same criteria as that established for metropolitan homes where adequate water, roads, street signs, house numbers and quick fire response are available. However, many homes in the wildland/urban interface exist in an environment where few of these factors are present giving rise to an increased threat from fire. “Fires in wildland/ urban interface areas also behave differently than fires in metropolitan areas. Fires typically move more rapidly, often “spotting” (jumping) sometimes up to a mile or more downwind (DCD & DNR, 1994, p. 9). However, damage from wildfires can be minimized if reasonable precautions are taken.

Local ordinances should continue to address construction in high-risk urban/wildland interface areas as recommended in the Washington Wildfire Mitigation Plan (1994). Clark County created and adopted a model ordinance for new home construction in high-risk wildfire areas. The Department of Natural Resources recommends this ordinance for use in other counties of the state. Several counties have adopted wildfire ordinances.

Engineering and Design

Buildings are designed by members of many professions including structural engineers, architects, building designers, and manufacturers of pre-fabricated buildings. Building codes are also subject to the interpretations of various structural design professional.

Pre-fabricated buildings exist in a highly cost competitive market. Consequently, they are sometimes designed without any additional safety factors other than minimum code requirements. Failure of pre-engineered buildings can be high during extreme weather events. This is especially true if modifications have been made that do not comply with the building code.

Construction Materials Grading

Predictable performance of building materials is essential to structural design. Over time, changes occur in construction material industries that may affect the quality of materials. If material standards are not maintained and verified within the industries, structural design assumptions could become invalid.
Recently, the structural capacity of some lumbers was downgraded. This could mean that buildings built after the downgrade may no longer perform to the levels anticipated by the design engineers, which is based on previously higher material standards.

Building Use and Maintenance

Improper use, alterations, or loading of critical structural members of a building can cause structural weakening of portions of or to an entire building. Lack of maintenance also can contribute to deterioration of the structural materials. Clogged roof drains can cause water to accumulate on the roof in such quantities as to cause the structure to overload and fail. Many roof failures during the 1996-97 winter storms occurred due to the inability of water to drain from the roof. Problems such as dry rot, rusting

of steel connectors or insect infestation can render a structural system ineffective.

Manufactured Homes

Manufactured homes should be located outside designated floodplains; however, this is where many low-income families reside. Manufactured homes in the flood plain are especially vulnerable to damage because foundation are not elevated and anchored to resist flotation, collapse, and lateral movement as required by the National Flood Insurance Program. Within the state, most of the manufactured homes damaged during the 1995-96 winter storms were sited prior to the publication of the National Flood Insurance Rate Maps and without permits or inspections. Many homes had no anchors. Other homes received damage because the anchors used were the wrong design for the type of soil or they where incorrectly installed (Greenhome, o'Mara & FEMA, 1996). One of the lessons learned from the floods of 1995-96 was that when manufactured homes are flooded, warping could be prevented or minimized if the belly board, wet wall, floor insulation, and wet carpet and padding, are immediately removed (Federal Emergency Management Agency, Region X, 1996).

The Department of Housing and Urban Development (HUD) requires a design wind load for manufactured housing of 76 mph nationwide. Conventionally built homes in the Puget Sound area must be able to withstand 80-mph winds. Some areas of Washington, especially the coast, experience winds exceeding 110 mph. Jurisdictions can require higher wind load factors, but rarely do. As of November 25, 1996, all manufactured homes must be tied down per the manufacturer's installation instructions.

Many roof failures during the 1996-97 winter storms were attributed to snow load. This either was due to the roof load capacity of the manufactured home, or improperly attached carports. Various building departments, the Department of Labor and Industries, and the Federal Emergency Management Agency, Region X, helped low-income areas design a freestanding carport during this time, which met local jurisdiction approval.

Unregulated Structures

The many waterways in the state are home to many floating structures. This can be a particular challenge as indicated by the numerous problems encountered during the 1996-97 storms, particularly in King and Snohomish Counties. Many floating homes or other structures were built without permits. Floating structures, especially if floatation is inadequate, can experience unique problems in both wind and snow load situations. Since these structures lack the anchoring system of conventional homes, they tend to topple and often sink. Local ordinances and building codes need to address these structures in order to prevent future problems.

Recommendations

High Priority Recommendations

Recommendation 12-1
Building departments should be more pro-active in citing builders/owners for building or modifying buildings without permits, or who fail to meet applicable building codes. Many structures that fail in windstorms or earthquakes are built without permits or proper engineering. Inadequate staffing of building departments and political pressures that contribute to non-enforcement must also be examined.

Recommended Lead Agency (ies): Washington Association of Building Officials and State Building Code Council.

Recommendation 12-2
Conduct research on building failures to determine if the building design and construction met code requirements. Designers and architects need to be included since their seal is on the line.

Recommended Lead Agency (ies): Washington Association of Building Officials, Structural Engineers Association of Washington.

Recommendation 12-3
To ensure public health, relocate or retrofit water systems and sewage treatment facilities so they are capable of functioning in any hazard.

Recommended Lead Agency (ies): DOH.

Recommendation 12-4
Conduct research to determine if pre-engineered buildings should be designed to higher load capacity standards. Contact structural engineers who have been involved in the assessments of particular buildings.

Recommended Lead Agency (ies): State Building Code Council, FEMA Region X, Structural Engineers Association of Washington.

Medium Priority Recommendations

Recommendation 12-5
Improve the quality of building materials, inspections, and code enforcement.

Recommended Lead Agency (ies): State Building Code Council, Washington Association of Building Officials, and local building departments.

Recommendation 12-6
Local officials should establish building standards based on local conditions that address inadequacies in the state code. Codes reflect minimum construction standards meant to protect life and safety by providing safe egress from a structure during or after a disaster. They do not prevent the structure from damage. The state legislature must determine if local jurisdictions can enforce minimum/maximum standards that differ from the state standards. They must also consider the ramifications of not allowing the higher standard.

Recommended Lead Agency(ies): Washington Association of Building Officials.

Recommendation 12-7
Encourage the use of nonflammable building materials, like metal roofing, especially in areas subject to urban wildfire.

Recommended Lead Agency(ies): State Building Code Council, prerogative of local jurisdiction.

Recommendation 12-8
Review city and county building/electrical codes with a view toward building in redundancy. Consider such items as uninterrupted power supply, back-up generators, back-up communications systems and redundant routing of utilities.

Recommended Lead Agency (ies): DCTED and public and private utility companies.

Recommendation 12-9
Design structures so roofs can handle anticipated snow accumulations. It is unacceptable to rely upon shoveling the snow off roofs as a means of reducing the snow load to design maximum.

Recommended Lead Agency (ies): State Building Code Council, Washington Association of Building Officials, local building officials, Structural Engineers Association of Washington.

Recommendation 12-10
Before insuring a building, the insurance industry should perform a thorough check up on building maintenance for ratings. Lack of proper maintenance was a large factor in the 1996-1997 winter storm building failures due to snow loads.

Lead agencies: Washington Association of Building Officials, Office of the Insurance Commissioner-Property and Loss Insurance Division.

Recommendation 12-11
Manufactured homes should be treated the same as all other building types and snow load design standards should be set by the local building officials. As of 1997, manufactured home construction is controlled at the federal level by Housing and Urban Development (HUD). HUD issued a letter giving local jurisdictions the latitude to increase snow load if covered by local ordinance.

Recommended Lead Agency (ies): Washington Association of Building Officials.

Low Priority Recommendations

Recommendation 12-12
To control wind damage, encourage adoption of building and subdivision codes that require urban-friendly vegetation.

Recommended Lead Agency (ies): Ecology, DCTED-Growth Management Services; State Building Code Council; local building officials and public works departments.

Recommendation 12-13
Undertake a study to determine the cause of pre-engineered building failures. In post construction, owners may alter the design or structure including wiring. For multifamily and commercial structures, an annual certificate of occupancy is required. Officials should be aware of design standards and ensure compliance.

Recommended Lead Agency(ies): State Building Code Council, Structural Engineers Association of Washington, Washington Association of Building Officials.

Recommendation 12-14
Modify wind load criteria for mobile homes that will meet expected local conditions.

Recommended Lead Agency(ies): Washington Association of Building Officials, Structural Engineers Association of Washington, and local building officials.

Issue 13

Public awareness of the state's many hazards, associated risks, and how to plan for or respond to such events is limited. As the population of the state grows, there is a continuing need for public education and awareness especially concerning earthquakes and tsunamis.

Discussion

Understanding Risk

Effective disaster preparedness and mitigation requires an increase in public awareness as to the warning signs and dangers associated with each hazard. By preparing for and mitigating the effects of disaster ahead of time, the community will be better able to take care of itself and prevent future damage. Knowing that hazards are present is not enough. It is also important that we understand the risk associated with each hazard. Some examples follow.

Many landslides that occurred in developed areas in past years could have been prevented with appropriate and timely construction, drainage, and management of the site. Identifying existing slides and/or other earth movement provides a basis for educating the public about the risk and provides a mechanism for reducing the risks by allowing evacuation and/or mitigation measures to occur during earlier stages of a slide.

Flooding takes place almost yearly somewhere in the state. People are infinitely aware that flooding takes place, yet every time a flood occurs, they seem to be caught off guard. Perhaps if they understood the personal risk they face in a flood, this would change. The U.S. Army Corps of Engineers, Seattle District has a model they use to educate various audiences on floodplains. This model shows the effects of flooding in relation to land use.

While most people have some knowledge of riverine flooding, few understand the risks of groundwater flooding. During the flood events of 1996-97, almost no groundwater flooding victims had flood insurance. Consequently, the Federal Emergency Management Agency, Region X, in coordination with the Regional National Flood Insurance Program, developed a strategy for marketing Preferred Risk Flood Insurance Policies to individuals living in B, C and X Zones. The strategy included examples of flooding from small urban streams, hillside drainage, groundwater ponding, and basement seepage that could be covered by a preferred risk policy. Materials were developed to assist communities participating in the Community Rating System to use in local outreach projects. Insurance agents were encouraged to promote "preferred" flood insurance policies for homes not located in a mapped floodplain. Training was conducted for insurance agents and materials were disseminated to property owners with assistance from local communities.

As the population of the state continues to grow, so does urban sprawl. More and more people are moving to the "country." Here again people know that wildfires occur; yet, they fail to understand the risk in living in the urban-wildland interface area. There are steps the public can take to reduce the risk from wildfires. These steps are understood by fire fighting agencies, but not generally well known or understood by the public, property developers, or local planners. "Residents in wildland/urban interface areas, property developers, and local planners all share the responsibility for mitigating the damage and costs resulting from wildfires. Such mitigation actions include using fire resistant roofing, providing adequate defensible space around the homes and structures, allowing for adequate ingress and egress routes, and providing adequate water supplies with back-up power (DCD & DNR, 1994, p.10).

Most people living in Washington know there are a number (five) of volcanoes in the state. They generally understand what happens in a volcanic eruption, but since eruptions are so infrequent, the peaks are in the far distance and warnings generally proceed volcanic activity, most are unconcerned. However, many fail to understand other risks associated with the volcanic hazard – namely lahars, which may come without warning and separate from a volcanic eruption. The U.S. Geological Survey, David J. Johnston Cascades Volcano Observatory, along with Pierce County and others continue to educate public officials and the public regarding the critical hazard posed by future lahars, especially in the valleys that drain Mount Rainier. Lahar inundation maps are now available for all the state's volcanoes.

Earthquakes get a lot of attention from the media, and public concern seems to be at a higher level than anytime in the past. Still, many fail to understand that one does not have to be on top of an earthquake fault to experience damage. There needs to be a greater understanding that the real risk from an earthquake may stem more from the ground we build on (liquefaction areas and other poor soils), one's location relative to other hazards (near hazardous material sites or large sources of water), whether or not structures were built using up-to-date building codes (earthquake bracing and securing homes to the foundation), and secondary hazards such as fire, than from the 15-30 seconds of ground shaking.

Incorrectly referred to as tidal waves, a tsunami is another hazard where risks are not well understood. People living in coastal communities are somewhat more informed than the occasional tourist. However, even long time coastal residents do not clearly know or understand the risk from tsunami inundation. Inundation maps are being developed, but are not readily available to the public. There are still a lot of people who do not understand that an earthquake along the Cascadia Subduction Zone may generate a tsunami so quickly, that a public warning may be

issued to late (if at all) to evacuate. During the fall of 1999, a series of public meetings was conducted in coastal communities to help people better understand the potential risks associated with tsunamis.

Opportunities for Enhanced Code Enforcement

Building owners and users are approved to occupy a structure when the local building officials have certified it as having met the current building standards for safe construction. After the building is certified for occupancy, its performance is highly dependent upon how it is used and maintained during its lifetime. The owners and occupants of the structure have the responsibility for maintaining the integrity of the structure. Changes to a structure, especially load bearing walls, can have a negative affect on the structure due to hazards like heavy snow, earthquake, or fire. There is an opportunity for building officials to keep in touch with owners by providing additional safety inspections or by offering informational forums. By staying in touch, the occupant can stay abreast of risks to the structure and may think to consult with the building department for current codes and permits before beginning a project that could someday result in catastrophic failure.

Warning

Hazard warnings also serve to educate the public about risk. However, to be effective risk education tools, the risk associated with warnings must be clearly understood.

Because the severity of storms is so variable, weather warnings are not always heeded. As an example, the ice, snow, and flood events of 1996-97 produced several deaths. These deaths quite possibly occurred due to a lack of understanding of the risk associated with the weather warnings issued for these events. The principle issue here is not only understanding weather related risks, but also decisions made that place non-essential government, business, or school personnel in a commute situation during especially bad weather, which increases the risk of injury or death. Policies that address delayed openings and/or working at alternative locations or even telecommuting should be developed ahead of time and used to mitigate the needless loss of life.

Training, Education and Technical Assistance

Training, public education and technical assistance are three methods of increasing knowledge of hazard related risks. All three are available through the Washington Military Department, Emergency Management Division, local emergency management offices and many state agencies as well. Publications explaining the state's hazards and associated risks are readily available in printed form or on the Internet.

In 1995, the Washington Military Department, Emergency Management Division, and the National Weather Service developed an information flyer titled "*Windstorms...The Day The Trees Turned Dangerous*." Additionally, the Department of Natural Resources has provided brochures regarding storm damaged trees and wildfire safety through the *Backyard Forest Stewardship* package. These flyers plus other educational materials can be used as a basis for community campaigns.

Mitigation Works

There is considerable evidence that prevention programs are cost effective. Hundreds of jurisdictions have demonstrated statistically that well documented programs aimed at children and adults have produced reductions in fire frequency and fire losses. Though most of the statistical evidence for prevention success comes from structural fires, many successes have been recorded with wildland and grassland programs. The Smokey Bear program is believed to be the primary reason that abandoned campfires now account for less than five percent of all wildland fire starts (nationwide) (Tridata Corporation, 1998).

The Department of Natural Resources (DNR) has implemented 21 fire prevention cooperatives through which 25-30,000 children (grades K-3) annually attend "Sparky" and "Learn Not to Burn" programs. The Office of the Superintendent of Public Instruction approved the K-3 curriculum. New wildfire curriculum has been developed for grades 6-10.
Through the Master Gardener program, DNR conducted a fire safe gardening program. In addition, through February 1997 they awarded 60 backyard defensible space certificates to individuals taking part in wildfire home survivability promotion. This effort was part of the Eastern Washington Backyard Forest Steward program. Consequently, actions taken in Airway Heights, Washington proved that defensible space works. Only eight homes burned in a 1994 fire.

Often times adults learn about hazards and risks from their children. Children who are taught earthquake or fire preparedness in schools bring the information home to the family. Many school districts are very involved in preparedness for fire, flood, and earthquake; a few are prepared for volcano. Consequently, so are many of the families of the children.
The DNR Forest Stewardship program works with non-industrial forest landowners to deliver the prevention message. The program's seven-week course in landowner forestry incorporates prevention instruction and materials provided by the Department of Natural Resources prevention office (TriData Corporation, 1998).

DNR has directly funded and jointly managed adult education activities in high-risk areas of the state. Home risk assessments were conducted in Clark, Mason, King, Thurston, east Lewis, Grays Harbor, and Ferry Counties in cooperation with local fire protection districts. The compliance rate for making fire safe changes to individual homes was as high as 80 percent.

Recommendations

High Priority Recommendations

Recommendation 13-1
Prepare or adopt a technical manual that illustrates methods for identifying site-specific landslide hazard areas.

Recommended Lead Agency (ies): DNR, and Ecology with assistance from the Seattle American Society of Civil Engineers, Geotechnical Group.

Medium Priority Recommendations

Recommendations 13-2
Provide a public education program on the hazards related to dumping non-engineered fill or debris over the side of a landslide susceptible or steep slope area or near the top of slopes.

Recommended Lead Agency (ies): Ecology, and DNR. Prerogative of local jurisdictions.

Recommendation 13-3
Prepare pamphlets on how to prepare for groundwater flooding and how to handle groundwater pumping and channeling.

Recommended Lead Agency (ies): Ecology and FEMA. Prerogative of local jurisdiction.

Recommendation 13-4
Develop a public education program that addresses the effects and locations of landslide hazards, factors contributing to the hazard, and referral sources available to concerned individuals. The public education program may consist of targeted mailings to homeowners in steep slope or coastal areas; pamphlets or booklets on specific hazards and recommended strategies in target areas made available to concerned individuals; or specific hazard workshops for property owners, realtors and developers. While some local jurisdictions are currently providing this service, there is a need

for continued funding for staff and training to sustain or start up this type of service.

Recommended Lead Agency (ies): DNR and Ecology. Prerogative of local jurisdictions.

Recommendation 13-5
Tsunami public education is needed to alert the public to the evacuation signs along the coast. For extremely low coastal areas with limited access, timing can be a real issue. Training needs to be developed and delivered. A state agency needs to be appointed by the state Legislature with appropriate funding to support these actions.

Recommended Lead Agency (ies): DNR and EMD.

Recommendation 13-6
Conduct research to better understand hazards within Washington State. For example, following the 1980 eruption of Mount St. Helens, there was a recommendation for geological and glaciological monitoring and research; seismic monitoring; thermal infrared studies; geochemical baseline measurements; flood mapping, and television monitoring of dams.

Recommended Lead Agency (ies): USGS.

Low Priority Recommendations

Recommendation 13-7
Develop an educational program that will help the public, builders, and owners understand the minimum construction standards of the building code.

Recommended Lead Agency(ies): Washington Association of Building Officials and the Washington State Building Code Council.

IMPLEMENTATION AND MONITORING

Role of State Hazard Mitigation Officer

Implementation of the Hazard Mitigation Strategy involves coordination by the State Hazard Mitigation Officer (SHMO), assisted by the Mitigation Strategist, with state hazard mitigation team members and local government officials whose agencies have been designated as having the responsibility for implementing specific recommendations. The SHMO will support implementation activities by assisting the lead agencies to identify, coordinate, and obtain the necessary technical and financial resources required for each recommendation. This may include conducting meetings that relate to the recommendation; holding training sessions; scheduling visits with the Governor's Office, legislative committees, state and federal agencies, private businesses, community groups, and the media: developing correspondence; and making phone calls. The purpose of these efforts is to stimulate and support mitigation activities and to solidify official commitment and public involvement.

Responsibilities of Lead Agencies

There are several activities lead agencies should pursue that contribute towards implementing recommendations. Lead agencies should educate colleagues within their respective agencies as to how the recommendations they have a lead responsibility for were formulated and why they are important. Ongoing programs and activities that either support or conflict with mitigation strategies should be identified to the Mitigation Strategist. Lead agencies are expected to coordinate technical and financial resources available from their agencies and generate any additional activities that will help accomplish implementation of recommendations.

Periodic Reporting Requirements

Lead agencies should report completed recommendations as soon as possible and provide annual updates on the progress of all open recommendations. Updates are due to the Washington Military Department, Emergency Management Division, Mitigation Strategist by 31 August each year. This allows one month for collation of all information for a yearly update to the Federal Emergency Management Agency (required by 44 CFR 206.406(I)) by the end of the federal fiscal year (September 30).

EVALUATION

Relevancy and Effectiveness of Goals, Objectives and Recommendations

The mitigation strategy will be monitored to ensure that the goals and objectives of Hazard Mitigation Strategic Plan and the recommendations in the *Hazard Mitigation Strategy* remain relevant. Consideration must also be given to the effectiveness of mitigation recommendations (strategies). To assist in this process the following checklist should be applied during the annual review or following any disaster declaration. "No" answers on the checklist require action.

Hazard Mitigation Strategy Evaluation Checklist

EVALUATION ITEM	YES	NO
1. Are the goals, objectives, and recommendations still applicable? Do strategy recommendations still correspond with state priorities?		
2. Are the issues the same? Are they different? Are the hazards the same? Are there new hazards that pose a threat that are not addressed in the strategy? Do new recommendations need to be developed for new hazards? Do existing recommendations need to be reprioritized for implementation?		
3. Is the strategy appropriate for the available resources? Are staff time and the required funding available to implement the recommendations? Do additional sources of funding need to be identified? Do lead agencies need to be reassigned for implementation?		
4. Are there problems with implementation, i.e., technical, political, legal, coordination, etc.? Is agency coordination a problem? Is the political atmosphere preventing recommendations from being implemented? Is it still feasible to pursue implementation of certain recommendations?		
5. Are the outputs/outcomes as expected? Have the priority recommendations been implemented? Have state agencies actively participated in implementing recommendations in the *Hazard Mitigation Strategy?*		

Table 1

MAINTENANCE

Periodic Plan Update

At the time of the next presidential disaster declaration, the state is required to update the *Hazard Mitigation Strategy*. A supplemental section may need to be developed to address new hazard mitigation needs or issues, reprioritize existing recommendations, or expand the strategy to address additional hazards.

Following the next presidential disaster declaration, FEMA and the state, with the assistance of the Hazard Mitigation Survey Team or Interagency Hazard Mitigation Team will complete an initial report on the event within 15-days. The *Hazard Mitigation Strategy* will be reviewed at this time to ensure the existing mitigation strategies (recommendations) are adequate to mitigate the effects of a similar disaster in the future. If an update of the *Hazard Mitigation Strategy* is necessary, a new mitigation strategy for the event will be developed and implemented within 180-days of the declaration. This new strategy will be filed at Appendix "F" and will be considered an update to the existing *Hazard Mitigation Strategy*.

If there are no declared disasters, the *Hazard Mitigation Strategy* will undergo a comprehensive review every five years. Recommendations listed in the *Hazard Mitigation Strategy* require an annual review.

Future Enhancements

The *Hazard Mitigation Strategy*, initiated before 1997, has fallen victim to inadequate staffing due in part to a number of presidential disaster declarations in the last two years. Consequently, the strategy has existed in draft form only for over two years and many of the original team members have moved on. The draft was reviewed by many of the original team members and their comments have been taken into consideration in developing the final version of this document. However, much has changed in two years. Consequently, during the year 2000 the Washington Military Department, Emergency Management Division will reassemble a state hazard mitigation team and perform a comprehensive review of the *Hazard Mitigation Strategy*, paying special attention to the "Issues and Recommendations" section. If major changes are required they will be documented and entered as a supplement in Appendix "F" until which time the strategy can be rewritten.

By the end of calendar year 2002, the *Hazard Mitigation Strategy* will be revised to accurately address mitigation requirements presented by all hazards. Currently, many mitigation strategies are contained in multiple other documents. An attempt will be made to bring them (at least the priority issues and recommendations) in to this document.

APPENDIX A - GLOSSARY

Alluvial Fan - Area of deposition where steep mountain drainages empty into valley floors, usually in arid regions. Flooding in these areas often includes characteristics that differ from those in riverine or coastal areas.

Alluvium - Sand, clay, etc., gradually deposited by moving water, as along a riverbed or the shore of a lake.

Anchor - A series of methods used to secure a structure to its footings or foundation all so that it will not be displaced by flood or wind forces.

Area of Shallow Flooding - A designated AO, AH, or VO zone on a community's Flood Insurance Rate Map (FIRM) with a one-percent or greater annual chance of flooding to an average depth of one to three feet where a clearly defined channel does not exist, the path of flooding is unpredictable, and velocity flow may be evident. Such flooding is characterized by ponding or sheet flow.

Area of Special Flood Hazard - The land in the floodplain within a community subject to a one-percent or greater chance of flooding in any given year. The area may be designated as Zone A on the FHBM. After detailed rate-making has been completed in preparation for publication of the FIRM, Zone A usually is refined into Zones A, AO, AH, A1-30, AE, A99, VO, or V1-30, VE, or V.

Area of Special Flood-Related Erosion Hazard - The land within a community that is most likely to be subject to severe flood-related erosion losses. The area may be designated as Zone E on the Flood Hazard Boundary Map (FHBM). After the detailed evaluation of the special flood-related erosion hazard area in preparation for publication of the FIRM, Zone E may be further refined.

Area of Special Mudslide Hazard - The land within a community most likely to be subject to severe mudslides (mudflows). The area may be designated as Zone M on the FHBM. After the detailed evaluation of the special mudslide (mudflow) hazard area in preparation for publication of the FIRM, Zone M may be further refined.

Avalanche Warning - See Extreme Avalanche Hazard

A-Zones - A-Zones are found on all Flood Hazard Boundary Maps (FHBMs), Flood Insurance Rate Maps (FIRMs), and Flood Boundary and Floodway Maps (FBFWMs). An A-Zone is an area that would be flooded by the Base Flood, and is the same as a Special Flood Hazard Area (SFHA) or a 100-year floodplain. These areas may be unnumbered as AE, AH, or AO Zones. Numbered A-Zones indicate an area's risk to flooding.

Backwater Effect - The rise in water surface elevation caused by some obstruction such as a narrow bridge opening, buildings, or fill material that limits the area through which the water must flow. Also referred to as "heading up."

Base Flood - A term used in the National Flood Insurance Program to indicate the minimum size flood to be used by a community as a basis for its floodplain management regulations; presently

required by regulation to be that flood which has a one-percent chance of being equaled or exceeded in any given year. Also known as a 100-year flood or one-percent chance flood.

Base Flood Elevation (BFE) - The elevation for which there is a one-percent chance in any given year that flood levels will equal or exceed it. The BFE is determined by statistical analysis for each local area and designated on the Flood Insurance Rate Maps. It is also known as the *100-Year Flood.*

Base Floodplain - The floodplain that would be inundated by a one-percent chance (100-year) flood.

Basin - The total area from which surface runoff is carried away by a drainage system. Other comparable terms are "drainage area," "catchment area," and "watershed."

Berm - A bank or mound of earth usually placed against a foundation wall.

Blizzard Warning - Considerable falling and/or blowing snow and winds of at least 35 miles per hour are expected for several hours. Also see Winter Storm Warning.

Breakaway Walls - A wall that is not part of the structural support of the building and is intended through its design and construction to collapse under specific lateral loading forces, without causing damage to the elevated portion of the building or supporting foundation system.

Building Code - The regulations adopted by a local governing body setting forth standards for the construction, addition, modification, and repair of buildings and other structures for the purpose of protecting the health, safety, and general welfare of the public.
Per RCW 19.27.050, the state building code required by this chapter shall be enforced by the counties and cities. Any county or city not having a building department shall contract with another county, city or inspection agency approved by the county or city for enforcement of the state building code within its jurisdictional boundaries.

Built Environment - Any person-made structures such as buildings, transportation and communication lines, and utilities.

Catastrophic Earthquake - A seismic event (or series of seismic events) that results in large numbers of deaths and injuries, extensive damage, or overwhelming demand on state and local response resources and mechanisms; a severe impact on national security facilities and infrastructures that sustain them; a severe long-term effect on general economic activity; and a severe effect on state, local, and private sector initiatives to begin and sustain initial response activities.

Channel - A natural or artificial watercourse with definite bed and banks to confine and conduct flowing water.

Channel Capacity - The maximum flow that can pass through a channel without overflowing the banks.

Climate - Meteorological conditions, including temperature, precipitation, and wind that prevail in a region. [*Webster's II New Riverside University Dictionary*. 1988.]

Closure - A shield made of strong material, such as steel, aluminum, or plywood, used to temporarily fill in gaps in floodwalls, levees, or sealed structures that have been left open for day-to-day convenience at entrances such as doors and driveways.

Coastal Flood Warning - Warns of significant wind-forced flooding expected along low-lying coastal areas within 12 hours. Damage to beaches, roads, and marinas is possible.

Coastal Flooding - Flooding common in low-lying areas along the Pacific Coast and the inland waters of Puget Sound. This flooding can be created when high tides combine with storm-related low barometric pressure to cause tidal flooding. In addition, winds along the coast may produce high waves that inundate small coastal areas.

Coastal High-Hazard Area - An area of special flood hazard, extending from offshore to the inland limit of a primary frontal dune, along an open coast and any other area subject to high velocity wave action from storms or seismic sources.

Coastal Zone Atlas - A map developed by the Department of Natural Resources that covers a strip one-half mile from shore along the Puget Sound and Straits of Juan de Fuca. The scale (1:24,000) is adequate for some site-specific applications but the methodology was qualitative (i.e., visual inspection for geomorphic evidence of landsliding) and therefore not generally useful for site applications.

Column - Upright support units for a building set in pre-dug holes and back filled with compacted material. Columns will often require bracing in order to provide adequate support. They are also known as *posts*, although they are usually of concrete or masonry construction.

Command Post - A centralized base of operations established near the site of an incident, located at a safe distance from an accident site, where the on-scene coordinator, responders, and technical representatives can make response decisions, deploy manpower and equipment, maintain liaison with media, and handle communications.

Community - Any state or area or political subdivision thereof, or any Indian tribe or authorized tribal organization that has the authority to adopt and enforce statutes for areas within its jurisdiction.

Community Rating System - This is an insurance rating system that allows participating communities to lower their flood rates in the National Flood Insurance Program. Credits are earned for various efforts made by a community to better prepare itself including through floodplain management planning, public information regarding hazards, and emergency services.

Contingency Plan - A document to identify and catalog the elements required to respond to an emergency, to define responsibilities and specific tasks, and to serve as a response guide.

Critical Action - An action for which even a slight chance of flooding is too great. The minimum floodplain of concern for critical actions is the 500-year floodplain (critical action floodplain).

Critical Feature - An integral and readily identifiable part of a flood protection system, without which the flood protection provided by the entire system would be compromised.

Cross Section - A graph or plot of ground elevation across a stream valley or a portion of it, usually along a line perpendicular to the stream or direction of flow.

Curvilinear Line - The border on either a FHBM or FIRM that delineates the special flood, mudslide (mudflow), and/or flood-related erosion hazard areas and consists of a curved or contour line that follows the topography.

Custodial Care Facilities - Those buildings, structures, or systems, including those for essential administration and support, which are used to provide institutional care for persons who require close supervision and some physical constraints on their daily activities for their self-protection but do not require day-to-day medical care.

Dam - A structure built across a waterway to impound water. Dams are used to control water depths for navigation; or to create space to store water for flood control, irrigation, water supply, hydropower, or other purposes.

Damage Assessment - The process of determining the magnitude of damage and the loss to individuals, businesses, the public sector, and the community resulting from a disaster or emergency event.

Debris Impact Loads - Sudden loads imposed on a structure by debris carried by floodwater.

Declaration - The formal action by the president to make a state eligible for major disaster or emergency assistance under the Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 93-288, as amended (the Stafford Act).

Deductible - The fixed amount or percentage of any loss covered by insurance that is borne by the insured prior to the insurer's liability.

Dense Fog Advisory - Visibility less than 1/4 mile for a widespread area.

Design Flood - Commonly used to mean the magnitude of flood used for design and operation of flood control structures or other protective measures. It is sometimes used to denote the magnitude of flood used in floodplain regulations.

Designated Area - Any emergency or major disaster-affected portion of a state that has been determined eligible for federal assistance.

Designated Floodway - The channel of a stream and that portion of the adjoining floodplain designated by a regulatory agency to be kept free of further development to provide for unobstructed passage of flood flows.

Development - Any manmade change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations, or storage of equipment or materials.

Dike - In most areas of the U.S., an earthen or rock structure built partway across a river for maintaining the depth and location of a navigation channel. In other areas, the term is used synonymously with levee.

Direct Impacts - Changes in floodplain or wetland values and functions and changes in the risk to lives and property caused or induced by an action or related activity. Impacts are caused whenever these natural values and functions are affected as a direct result of an action. An action that would result in the discharge of polluted storm waters into a floodplain or wetland, for example, would directly affect their natural values and functions. Construction-related activities, such as dredging and filling operations within the floodplain or a wetland would be another example of impacts caused by an action.

Disaster Recovery Manager (DRM) - The person appointed to exercise the authority of a regional director for a particular emergency or disaster.

Disaster/Emergency - See RCW 38.52.010 (6)(a) emergency or disaster as used in all sections of this chapter except RCW 38.52.430 shall mean an event or set of circumstances which: (I) demands immediate action to preserve public health, protect life, protect public property, or to provide relief to any stricken community overtaken by such occurrences, or (ii) reaches such a dimension or degree of destructiveness as to warrant the governor declaring a state of emergency pursuant to RCW 43.06.010.

RCW 38.52.010 (6)(b) emergency as used in RCW 38.52.430 means an incident that requires a normal police, coroner, fire, rescue, emergency medical services, or utility response as a result of a violation of one of the statutes enumerated in RCW 38.52.430.

Drought Conditions - Drought conditions are water supply conditions where a geographical area or a significant part of a geographical area is receiving, or is projected to receive, less than seventy-five percent of normal water supply as the result of natural conditions and the deficiency causes, or is expected to cause, undue hardship to water users within that area.

Dry Floodproofing - A floodproofing method used in areas of low level flooding to completely seal a home against water. Sometimes referred to as sealing.

Elevation - The raising of a structure to place it above flood waters on an extended support structure.

Eligible Community - A community for which the administrator has authorized the sale of flood insurance under the National Flood Insurance Program.

Emergency Actions - Emergency work essential to save lives and protect property and public health and safety performed under Section 306 of the Disaster Relief Act of 1974.

Emergency Facilities - Those buildings, structures, equipment, or systems used to provide emergency services, such as fire protection, ambulance, or rescue, to the general public, including the administrative and support facilities essential to the operation of such emergency facilities even if not contiguous.

Emergency Operations Plan (EOP) - An all-hazards document, that specifies actions to be taken in the event of natural disasters, technological accidents, or nuclear attack; identifies authorities, relationships, and the actions to be taken by whom, what, when, and where, based on predetermined assumptions, objectives, and existing capabilities.

Emergency Program (EP) - The phase of the National Flood Insurance Program that a community enters before the completion of an individual community flood insurance study. It is intended to provide a first-layer amount of insurance at federally subsidized rates on all existing structures and new construction begun prior to the effective date of a Flood Insurance Rate Map, in return for the community's adoption of general floodplain management regulations.

Emergency Response - The response to any occurrence that results, or is likely to result, in the loss of lives and/or property.

Emergency Work - Work that must be done immediately to save lives and to protect improved property and public health and safety, or to avert or lessen the threat of a major disaster.

Encroachment - Any physical object placed in a floodplain that hinders the passage of water or otherwise affects flood flows, such as landfills or buildings.

Engineering Geologist - Geologist with Bachelor's of Science in engineering geology with demonstrated background in engineering geology.

Environment - Water, air, and land, and the interrelationship that exists among and between them and all living things.

Erosion - The wearing away of the land surface by running water, wind, ice, or other geological agents.

Essential Link - That portion of a road, utility, or other facility originating outside of the system unit but providing access or service through the unit and for which no alternative route is reasonably available.

Evacuation - A population protection strategy involving orderly movement of people away from an actual or potential hazard, and providing reception centers for those without their own resources for temporary relocation.

Executive Order 12699 - Requires that new construction of federal buildings must comply with appropriate seismic design and construction standards.

Executive Orders 11988 and 11990 - The requirements to avoid direct or indirect support of floodplain development and to minimize harm to floodplains and wetlands. federal decision-makers are obligated to comply with these orders, accomplished through an eight-step decision making process.

Existing Construction - As used in reference to the National Flood Insurance Program, any structure already existing or on which construction or substantial improvement was started prior to the effective date of a community's floodplain management regulations.

Existing Facility - According to PL 97-348, means a publicly owned or operated facility on which the start of construction took place before October 18, 1982, and for which this fact can be adequately documented. In addition, a legally valid building permit or equivalent documentation, if required, must have been obtained for the construction before October 18, 1982. If a facility has been substantially improved or expanded since October 18, 1982, it is not an existing facility. For any other unit added to the CBRS by amendment to PL 97-348, the enactment date of such amendment is substituted for October 18, 1982, in this definition.

Expansion - Changing a facility to increase its capacity or size.

Extended Foundation - The construction of additional walls above existing foundation walls in order to elevate a structure above flood levels.

Extreme Avalanche Hazard - (Avalanche Warning) Widespread areas of unstable snow exist and avalanches are certain on some snow-covered open slopes and gullies. Large destructive avalanches are possible. Backcountry travel should be avoided.

Facility - Any publicly or privately owned building, works, system, or equipment, built or manufactured, or an improved and maintained natural feature. Land used for agricultural purposes is not a facility.This includes any publicly owned flood control, navigation, irrigation, reclamation, public power, sewage treatment and collection, water supply and distribution, watershed development, or airport facility; and non-federal-aid street, road, or highway; and any other public building, structure, or system, including those used for educational, recreational, or cultural purposes, or any park.

Federal Coordinating Officer (FCO) - The person appointed by the director, or in his/her absence, by the deputy director, or alternatively by the associate director, to coordinate federal assistance in an emergency or a major disaster.

Federal Emergency Management Agency (FEMA) - This agency was created in 1979 to provide a single point of accountability for all federal activities related to disaster mitigation and emergency preparedness, response, and recovery.

Federal Hazard Mitigation Officer (FHMO) - The FEMA employee responsible for representing the agency for each declaration in carrying out the overall responsibilities for hazard mitigation and for Subpart M, including coordinating post-disaster hazard mitigation actions with other agencies of government at all levels.

Federal Insurance Administration (FIA) - The government unit (a part of FEMA) that administers the National Flood Insurance Program.

FEMA/State Agreement - A formal legal document between FEMA and the affected state stating the understandings, commitments, and binding conditions for assistance applicable as the result of the major disaster or emergency declared by the President. It is signed by the FEMA Regional Director, or designee, and the governor.

Fill - Material such as earth, clay, or crushed stone that is dumped in an area and compacted to increase ground elevation.

Financial Assistance - Any form of loan, grant, guaranty, insurance, payment, rebate, subsidy, disaster assistance loan or grant, or any other form of direct or indirect federal assistance, other than general or special revenue sharing or formula grants made to states.

Five Hundred-Year Floodplain - Also known as the 0.2-percent chance floodplain. The area, including the base floodplain, subject to inundation from a flood and having a 0.2-percent chance of being equaled or exceeded in any given year.

Flash Flood - A flood that crests in a short period and is often characterized by high velocity flow. It is often the result of heavy rainfall in a localized area.

Flash Flood Warning - Means that flash flooding is occurring or imminent on certain streams or designated areas and those threatened should take immediate action.

Flash Flood Watch - Flash flooding is possible within the watch area, but occurrence is neither certain or imminent. Citizens should be alerted to the possibility of a flood emergency that will require immediate action.

Flash Floods - Floods characterized by rapidly moving flood waves. These extraordinarily dangerous floods can roll boulders, tear out trees, destroy buildings and bridges, and scour out new stream channels. Heavy rainfall, geological and topographic features that encourage rapid storm flow and increasing development in hazardous areas combine to increase the danger of these floods.

Flood Boundary And Floodway Map - A map that is prepared during the course of a detailed flood insurance study of a community's flood hazard area. For the 100-year flood, the map shows the location of the floodway and the limits of the floodplain area.

Flood Boundary Floodway Map (FBFM) - The FBFM is a map that may be included with a Flood Insurance Study printed before 1986. It identifies the floodway and, along with the study, provides the technical basis for floodplain management regulations.

Flood Control - Keeping flood waters away from specific developments or populated areas by the construction of flood storage reservoirs, channel alterations, dikes and levees, bypass channels, or other engineering works.

Flood Crest - The maximum stage or elevation reached or expected to be reached by the waters of a specific flood at a given location.

Flood Duration - The length of time a stream is above flood stage or overflowing its banks.

Flood Elevation Determination - A determination by the administrator of the water surface elevations of the base flood, that is, the flood level that has a one percent or greater chance of occurrence in any given year.

Flood Elevation Study - An examination, evaluation, and determination of flood hazards and, if appropriate, corresponding water surface elevations, or an examination, evaluation, and determination of mudslide (mudflow) and/or flood-related erosion hazards.

Flood Fighting - Actions taken immediately before or during a flood to protect human life and to reduce flood damages such as evacuation, emergency sandbagging and diking, and provision of assistance to flood victims.

Flood Forecasting - The process of predicting the occurrence, magnitude, and duration of an imminent flood through meteorological and hydrological observations and analysis.

Flood Frequency - A statistical expression of the average time period between floods equaling or exceeding a given magnitude. For example, a 100-year flood has a magnitude expected to be equaled or exceeded on the average of once every hundred years; such a flood has a one-percent chance of being equaled or exceeded in any given year. Often used interchangeably with recurrence interval.

Flood Fringe - The portion of the floodplain that lies beyond the floodway and serves as a temporary storage area for flood waters during a flood. This section receives waters that are shallower and of lower velocities than those of the floodway.

Flood Hazard Boundary Map (FHBM) - The official map of a community that shows the boundaries of the floodplain and special flood hazard areas that have been designated. It is prepared by FEMA, using the best flood data available at the time a community enters the emergency phase of the NFIP. It is superseded by the FIRM after a more detailed study has been completed.

Flood Insurance - The insurance coverage provided under the National Flood Insurance Program.

Flood Insurance Rate Map (FIRM) - The official map of a community prepared by FEMA, which shows the base flood elevation, along with the special hazard areas and the risk premium zones. The study is funded by FEMA and is based on detailed surveys and analysis of the site-specific hydrologic characteristics.

Flood Insurance Rate Zone - A zone identified on a Flood Insurance Rate Map (FIRM) as subject to a specified degree of flood, mudslide (mudflow), or flood-related erosion hazards, to which a particular set of actuarial rates and floodplain management requirements applies.

Flood Insurance Study (FIS) - A study funded by FEMA and FIA and carried out by any of a variety of agencies and consultants to delineate the special flood hazard areas, base flood elevations, and NFIP actuarial insurance rate zones. The study is based on detailed site surveys and analysis of site-specific hydrologic characteristics.

Flood or Flooding - Temporary inundation of normally dry land areas from the overflow of inland or tidal waters, or from the unusual and rapid accumulation or runoff of surface waters from any source. The rise in water may be caused by excessive rainfall, snowmelt, natural stream blockages, wind storms over a lake, or any combination of such conditions.

Flood Potential Outlook - Issued if conditions indicate a potential for flooding in 36-72 hours.

Flood Profile - A graph showing the relationship of water surface elevation to a specific location, the latter generally expressed as distance above the mouth of a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific magnitude of flooding, but may be prepared for conditions at any given time or stage.

Flood Protection System - The physical structural works for which funds have been authorized, appropriated, and expended and which have been constructed specifically to modify flooding in order to reduce the extent of the area within a community subject to a "special flood hazard" and the extent of the depths of associated flooding. Such a system typically includes hurricane tidal barriers, dams, reservoirs, levees, or dikes. These specialized flood modifying works are those constructed in conformance with sound engineering standards.

Flood Statement - Updated or revised information issued periodically during flood watch/warning period, and used to cancel a flood watch/warning.

Flood Warning - The issuance and dissemination of information about an imminent or current flood. Flooding is forecast to occur within 12 hours on specific rivers. This is issued when rivers are forecast to crest at or above an established flood stage; or in the absence of an established flood stage, at a stage when action may need to be taken.

Flood Watch - Conditions suggest potential for flooding to occur in 12-36 hours. The statement will name specific rivers for the watch.

Flood Zones - Zones on the Flood Insurance Rate Map (FIRM) in which the risk premium insurance rates have been established by a Flood Insurance Study.

Floodplain - Any normally dry land area that is susceptible to being inundated by water from any natural source. This area is usually low land adjacent to a river, stream, watercourse, ocean, or lake.

Floodplain Management (FPM) - The operation of a program of corrective and preventive measures for reducing flood damage, including but not limited to flood control projects, floodplain land use regulations, floodproofing of buildings, and emergency preparedness plans.

Floodplain Regulations - General term applied to the full range of codes, ordinances, and other regulations relating to the use of land and construction within floodplain limits. The term encompasses zoning ordinances, subdivision regulations, building and housing codes, encroachment laws, and open area (space) regulations.

Floodproofing - Any combination of structural and nonstructural additions, changes, or adjustments to properties and structures that reduce or eliminate flood damage to lands, water and sanitary facilities, structures, and contents of buildings.

Flood-Related Erosion - The collapse or subsidence of land along the shore of a lake or other body of water as a result of undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm, or by an unanticipated force of nature, such as a flash flood or an abnormal tidal surge, or by some similarly unusual and unforeseeable event that results in flooding.

Flood-Related Erosion Area - A land area adjoining the shore of a lake or other body of water that, due to the composition of the shoreline or bank and high water levels or wind-driven currents, is likely to suffer flood-related erosion damage.

Flood-Related Erosion Area Management - The operation of an overall program of corrective and preventative measures for reducing flood-related erosion damage, including, but not limited to, emergency preparedness plans, flood-related erosion control works, and floodplain management regulations.

Floodwall - A constructed barrier of resistant material, such as concrete or masonry block, designed to keep water away from a structure.

Floodway - The channel of a watercourse and the portions of the adjoining floodplain required to provide for the passage of the selected flood (normally the 100-year flood) with an insignificant increase in the flood levels above that of natural conditions. As used in the National Flood Insurance Program, floodways must be large enough to pass the 100-year flood without causing an increase in elevation of more than a specified amount (one foot in most areas).
Floodways are shown on the Flood Boundary and Floodway Maps (FBFM) prepared by the Federal Emergency Management Agency for regular program communities. Upon the adoption of these maps by a community, the floodway(s) shown become "regulatory floodways" within which encroachment or obstructions must be prohibited.

Floodway Encroachment Lines - The lines marking the limits of floodways on federal, state, and local floodplain maps.

Footing - The enlarged base of a foundation wall, pier, or column, designed to spread the load of the structure so that it does not exceed the soil bearing capacity.

Forest Practices - Activities involving the management of public lands and practices involving the management of forests and the harvesting of timber. Washington State Forest Practices Act (Washington Administrative Code Chapter 222 and the Revised Code of Washington, Chapter 76.09).

Foundation - The underlying structure of a building, usually constructed of concrete, that supports the foundation walls, piers, or columns.

Foundation Walls - A support structure that connects the foundation to the main portion of the building, or superstructure.

Freeboard - An additional amount of height used as a factor of safety in determining the design height of a floodproofing or retrofitting method to compensate for unknown factors such as wave action. Certain guidelines and restrictions apply for establishing freeboard on levees and floodwalls in NFIP areas.

Freezing Rain Advisory - Ice conditions make roads, sidewalks, etc., hazardous or causes tree branches and power lines to break. Also see Ice Storm Warning.

Functionally Classed Roads - The state Department of Transportation has roads that are considered on system, such as interstates, state highways, state routes, primary, and secondary roads.

Functionally Dependent Use - A use that cannot perform its intended purpose unless it is located or carried out in close proximity to water (bridges and piers, for example). The term includes only docking facilities, port facilities that are necessary for the loading and unloading of cargo or passengers, and shipbuilding and ship-repair facilities, but does not include long-term storage or related manufacturing facilities.

Funnel Cloud - A rotating column of air forming a pendant from a cumulus/cumulonimbus cloud with circulation not reaching the ground.

Gale Warning - (Marine) A gale warning is issued when sustained winds or frequent gusts are expected to be between 34-47 knots (39 to 54 mph). Also, see Whole Gale Warning.

Geology - Structure of a specific region of the Earth's surface.

Geomorphic - Pertaining to the shape of the earth or its topography.

Geotechnical Engineer - Licensed civil engineers with education in geotechnical engineering; geologists (who generally identify landslide hazards along with the failure mechanism and provide nonstructural mitigation recommendations) and geotechnical engineers (who identify and make recommendations to mitigate and control landslide hazards).

Geotechnical P.E. - Practicing Engineer (may have degree in Civil Engineering); Masters in Science in geotechnical engineering; and five years experience.

Governor's Proclamation - The governor of Washington State can proclaim an emergency or disaster when a catastrophic event occurs and local and state resources have been exhausted. RCW 43.06.210.

Governor's Authorized Representative - The person empowered by the governor to execute, on behalf of the state, all necessary documents for disaster assistance.

Grant - An award of financial assistance. The grant award shall be based on the total eligible federal share of all approved projects.

Grantee - The government to which a grant is awarded that is accountable for the use of the funds provided. The grantee is the entire legal entity even if only a particular component of the entity is designated in the grant award document. For purposes of the regulation, except as noted in 206.202, the state is the grantee.

Groundwater Recharge - The infiltration of water into the earth. It may increase the total amount of water stored underground or only replenish supplies depleted through pumping or natural discharge.

Hazard - Any situation that has the potential for causing damage to life, property, and/or the environment.

Hazard Identification - The Hazard Identification provides a structured approach for identifying those hazards judged by local officials to pose a significant threat to their jurisdiction.

Hazard Mitigation - Any cost-effective measure that will reduce the potential for damage to a facility from a disaster event.

Hazard Mitigation Assistance Program - Provides a limited amount of funding to states to cover or to assist in covering the cost of preparing a pre-disaster hazard mitigation plan, one or more components of such a plan, or a related activity that will contribute to reducing vulnerability to hazards either throughout the state or for a selected area within the state.

Hazard Mitigation Grant Program - Authorized under Section 404 of the Stafford Act. Provides funding for hazard mitigation projects that are cost-effective and complement existing post-disaster mitigation programs and activities by providing funding for beneficial mitigation measures that are not funded through other programs.

Hazard Mitigation Plan - The plan resulting from a systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards present in society that includes the actions needed to minimize future vulnerability to hazards. The title of the state plan is *Washington State Hazard Mitigation Strategy*.

Hazard Mitigation Plan Update - An update to an existing hazard mitigation plan, which may be accomplished either by updating the status of mitigation actions within the existing plan or by expanding the existing plan to address additional hazards or mitigation issues.

Hazard Mitigation State Administrative Plan - The plan developed by the state to describe the procedures for administration of the Hazard Mitigation Grant Program.

Hazard Mitigation Survey Team - The FEMA/state/local survey team activated following disasters to identify immediate mitigation opportunities and issues. The Hazard Mitigation Survey Team may include representatives of other federal agencies, as appropriate.

Hazard Mitigation Survey Team Report - Developed by the Hazard Mitigation Survey Team, and similar in format to the Interagency Hazard Mitigation Team Report, the report identifies mitigation measures for implementation and recommends issues to be addressed in the state hazard mitigation plan, including those measures recommended for funding under the Hazard Mitigation Grant Program.

Hazard Warning - Any words, pictures, symbols, or combination thereof, appearing on a label or other appropriate form of warning, that convey the hazard(s) of the chemical(s) in the container(s).

Hazardous Chemicals - All chemicals that constitute a physical hazard or a health hazard as defined by 29 CFR 1910.1200(c), with the exception listed in Sec. 311(3). Any chemical that is a physical hazard or a health hazard.

HazMat - Hazardous Materials: Any substance or material in a particular form or quantity that the Secretary of Transportation finds may pose an unreasonable risk to health, safety, and property, or any substance or material in a quantity or form that may be harmful to humans, animals, crops, water systems, or other elements of the environment if accidentally released. Substances so designated may include explosives, radioactive materials, etiologic agents, flammable liquids or solids, combustible

solids, poisons, oxidizing or corrosive materials, and flammable gases. Defined via rulemaking process, under authority of PL 93-633.

Heavy Snow Warning - A lowland snowfall of at least 4 inches or more in 12 hours or 6 inches in 24 hours is expected. In the mountains, heavy snow is 12 inches in 12 hours. Also see Winter Storm Warning.

Heavy Surf Advisory - Swells of 20 feet or more are occurring or forecast to occur within 12 hours in coastal areas, and is issued in a Marine Weather Statement. Early in the storm season, an "Advisory" may be issued for swells of 15 feet or more.

High Wind Warning - Winds of at least 40 mph or gusts to 55 mph are expected within the next 12 hours to last for one hour or more.

High Wind Watch - High winds may occur in an area predicted within 12-36 hours.

Human Intervention - The required presence and active involvement of people to enact any type of floodproofing or retrofitting measure prior to flooding.

Hydrodynamic Loads - Forces imposed on structures by floodwaters due to the impact of moving water on the upstream side of the structure, drag along its sides, and eddies or negative pressures on its downstream side.

Hydrograph - A graph that charts the passage of water as a function of time. It shows flood stages, depicted in feet above mean sea level or gage height, plotted against stated time intervals.

Hydrology - The science of the behavior of water in the atmosphere, on the earth's surface, and underground.

Hydrostatic Loads - Forces imposed on an object, such as a structure, by water moving around it. Among these loads are positive frontal pressure against the structure; drag effect along the sides; and negative pressure on the downstream side.

Ice Dam - An ice dam is an accumulation of ice at the lower edge of a sloped roof when there is a layer of snow on the roof. Heat rises in the attic causing the warming of the roof. As the snow melts, the water runs under the snow to the edge of the roof. At the edge, which extends beyond the warmth of the house interior, the water again freezes, forming a layer of ice under the snow. Gutters can quickly turn to a solid block that becomes part of the iced roof edge. This is referenced in Chapter 15 in the 1996 UBC

Ice Storm Warning - Ice accumulations of 1/4 inch or more. More serious than a Freezing Rain Advisory. Also see Winter Storm Warning.

Immediate Threat - The threat of additional damage or destruction from an event that can reasonably be expected to occur within five years.

Impact Loads - Loads induced by solid objects carried by floodwater that collide into a structure. Debris can include trees, lumber, displaced sections of structures, tanks, runaway boats, and chunks of ice. Debris impact loads are difficult to predict accurately, yet reasonable allowances must be made for them in the design of potentially affected structures.

Impermeable Surfaces - Solid surfaces such as paved roads, parking lots, and building foundations that are not permeated by water. These surfaces cause water to run off in contrast to permeable surfaces such as soil that allows water to infiltrate.

Improved Property - A structure, facility, or item of equipment that was built, constructed, or manufactured. Land used for agricultural purposes is not improved property.

Incident Command System (ICS) - Combination of facilities, equipment, personnel, procedures, and communications, operating within a common organizational structure, with responsibility for managing assigned resources to effectively direct and control the response to an incident. Intended to expand as situation requires greater resources, without requiring new, reorganized command structure.

Indirect Impacts - An indirect result of an action whenever the action induces or makes possible related activities that affect the natural values and functions of floodplains or wetlands or the risk to lives and property. Such impacts occur whenever these values and functions are potentially affected, either in the short- or long-term, because of undertaking an action.

Individual Assistance (IA) - Supplementary federal assistance provided under the Stafford Act to individuals and families adversely affected by a major disaster or an emergency. Such assistance may be provided directly by the federal government or through state or local governments or disaster relief organizations.

Infiltration - The flow of fluid into a substance through pores or small openings. The word is commonly used to denote the flow of water into soil.

Insurance Adjustment Organization - Any organization or person engaged in the business of adjusting loss claims arising under the Standard Flood Insurance Policy.

Insurance Company - Any person or organization authorized to engage in the insurance business under the laws of any state.

Integrated Emergency Management System (IEMS) - Strategy for implementing emergency management activities, which builds upon those functions common to preparedness for any type of occurrence and provides for special requirements of individual emergency situations. Seeks function-based plan annexes that can be adapted to varied hazard events.

Interactive Hazards - Hazards created by other hazards. Examples include floods causing chemical and hazardous material spills or floods carrying pesticides and contaminants from agricultural activities into downstream locations.

Interagency Agreement for Post-Flood Hazard Mitigation - Agreement signed by 12 federal agencies as a result of a July 10, 1980, directive issued by the Office of Management and Budget to these agencies to coordinate their post-disaster recovery assistance following presidentially declared flood disasters, and to use this assistance to promote nonstructural approaches to reducing future flood damages.

Interagency Hazard Mitigation Team (IHMT) - The mitigation team that is activated following flood-related disasters pursuant to the Office of Management and Budget directive on Nonstructural Flood Protection Measures and Flood Disaster Recovery, and the subsequent December 15, 1980, Interagency Agreement for Nonstructural Damage Reduction.

Interagency Hazard Mitigation Team Report - Developed within 15 days following any presidentially declared flood disaster by an interagency, intergovernmental, and interdisciplinary team representing each of the signatory agencies of the Interagency Agreement for Post-Flood Hazard Mitigation. The report identifies post-flood mitigation opportunities and common post-flood recovery policies.

Interior Grade Beam - A section of a floor slab that has a thicker section of concrete to act as a footing to provide stability under load-bearing or critical structural walls.

Lahar - Volcanic debris flow that looks and behaves like flowing wet concrete. These gravity flows become channeled into valleys. Dependent upon size, these flows can quickly overwhelm all structures and debris in its path. At Mount Rainier, past lahars have been estimated at 50 miles

Lee - The side sheltered or protected from the wind.

Levee - A manmade structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices, to contain, control, or divert the flow of water so as to provide protection from temporary flooding.

Levee System - A flood protection system that consists of a levee, or levees, and associated structures, such as closure and drainage devices, which are constructed and operated in accordance with sound engineering practices.

Level of Protection - The greatest flood level against which a protective measure is designed to be fully effective; often expressed as a recurrence interval (100-year level of protection) or as an exceedance frequency (one-percent chance of exceedance).

Liability - An obligation to do or refrain from doing something; a duty that eventually must be performed; or an obligation to pay money. Also used to refer to one’s responsibility for his/her conduct.

Lift - A layer of soil that is compacted before the next layer is added in the construction of a fill pad or levee.

Local Government - Any county, city, village, town, district, or other political subdivision of any state, any Indian tribe or authorized tribal organization, or Alaskan native village or organization,

including any rural community or unincorporated town or village or any other public entity for which an application for assistance is made by a state or political subdivision thereof.

Local Hazard Mitigation Officer (LHMO) - The representative of local government who serves on the Hazard Mitigation Survey Team or the Interagency Hazard Mitigation Team and who is the primary point of contact with FEMA, other federal agencies, and the state in the planning and implementation of post-disaster hazard mitigation activities.

Lowest Floor - The lowest floor of the lowest enclosed area (including basement). An unfinished or flood-resistant enclosure, usable solely for parking of vehicles, building access, or storage in an area other than a basement area is not considered a building's lowest floor, *provided* that such enclosure is not built so as to render the structure in violation of the applicable non-elevation design requirements of 60.3.

Major Disaster - Any natural catastrophe (including any hurricane, tornado, storm, high water, wind-driven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snow-storm, or drought), or, regardless of cause, any fire, flood, or explosion, in any part of the United States, which, in the determination of the president, causes damage of sufficient severity and magnitude to warrant major disaster assistance under the Stafford Act to supplement the efforts and available resources of states, local governments, and disaster relief organizations in alleviating the damage, loss, hardship, or suffering caused thereby.

Mangrove Stand - An assemblage of mangrove trees, which are mostly low trees noted for a copious development of interlacing adventitious roots above the ground, and which contain one or more of the following species: Black mangrove (Avicennia Nitida); red mangrove (Rhizophora Mangle); white mangrove (Languncularia Racemosa); and buttonwood (Conocarpus Erecta).

Manufactured Home - A structure, transportable in one or more sections, which is built on a permanent chassis and is designed for use with or without a permanent foundation when connected to the required utilities. For floodplain management purposes, the term "manufactured home" also includes park trailers, travel trailers, and other similar vehicles placed on a site for longer than 100 consecutive days.

Manufactured Home Park (Subdivision) - A parcel (or contiguous parcels) of land divided into two or more manufactured home lots for rent or sale.

Mean Sea Level - The average height of the sea for all stages of the tide, usually determined from hourly height observations over a 19-year period on an open coast or in adjacent waters having free access to the sea. The National Geodetic Vertical Datum (NGVD) of 1929 or other datum to which base flood elevations shown on a community's Flood Insurance Rate Map are referenced.

Medical Facility - Any hospital, outpatient facility, rehabilitation facility, or facility for long-term care as defined in section 645 of the Public Health Service Act (42 U.S.C. 2910), and any similar facility offering diagnosis or treatment of mental or physical injury or disease, including the administrative and support facilities essential to the operation of such medical facilities, even if not contiguous.

Mudslide - Describes a condition where there is a river, flow, or inundation of liquid mud down a hillside, usually as a result of a dual condition of loss of brush cover and the subsequent accumulation of water on the ground, preceded by a period of unusually heavy or sustained rain. A mudslide (mudflow) may occur as a distinct phenomenon while a landslide is in progress, and will be recognized as such by the administrator only if the mudflow, and not the landslide, is the proximate cause of damage that occurs.

Mudslide Area Management - The operation of an overall program of corrective and preventive measures for reducing mudslide (mudflow) damage, including, but not limited to, emergency preparedness plans, mudslide control works, and floodplain management regulations.

Mudslide Prone Area - An area with land surfaces and slopes of unconsolidated material where the history, geology, and climate indicate a potential for mudflow.

Multi-Objective Management - A concept for projects that look at multiple opportunities to have environmental solutions for flooding, as well as enhancements for the public use.

National Flood Insurance Program (NFIP) - Created by an act of Congress in 1968, this FEMA managed insurance program makes flood insurance available in communities that enact satisfactory floodplain management regulations. The state program is coordinated by the state Department of Ecology, for reimbursement for flood damage to insured buildings and contents in participating communities in declared and nondeclared counties. Preferred rate insurance is available for homes not in a floodplain

New Construction - For the purposes of determining insurance rates, structures for which the "start of construction" commenced on or after the effective date of an initial FIRM, or after December 31, 1974, whichever is later, including any subsequent improvements to such structures.
For floodplain management purposes, "new construction" means structures for which the "start of construction" commenced on or after the effective date of a floodplain management regulation adopted by a community and includes any subsequent improvements to such structures.

New Financial Assistance - On a unit of the CBRS established by PL 97-348, an approval by FEMA of a project application or other disaster project application or other disaster assistance after October 18, 1982. For any other unit added to the CBRS by amendment to PL 97-348, the enactment date of such amendment is substituted for October 18, 1982, in this definition.

New Manufactured Home Park - A manufactured home park or subdivision for which the construction of facilities for servicing the lots on which the manufactured homes are to be affixed (including at a minimum, the installation of utilities, the construction of streets, and either final site grading or the pouring of concrete pads) is completed on or after the effective date of floodplain management regulations adopted by a community.

Nonstructural Floodplain Management Measures - Measures employed to modify the exposure of buildings to floods, that is, floodproofing, land use planning, warning schemes, and insurance, as opposed to structural measures such as dams, levees, and channel modifications.

Non-Velocity Coastal Flood Area - Any area that is subject to inundation by tidal waters that has lower velocity or wave components than a Coastal High Hazard Area.

Noxious Weeds - Noxious weeds are non-native, invasive plants that can displace native plant communities. Any plant which when established is highly destructive, competitive, or difficult to control by cultural or chemical practices. These weeds include Canada Thistle, Tansy Ragwort, Scot's Broom, St. John's Wort, and others and can be toxic to livestock.

Nuisance Abatement - Condemnation of property by a local jurisdiction to abate or lessen a hazardous situation.

One Hundred (100)- Year Flood - For the purposes of floodplain management, floods are defined by their "recurrence interval," or "frequency." The 100-year flood, for example, is a flood elevation that has a one-percent chance of being equaled or exceeded in any given year. It is also known as the base flood elevation.

Participating Community - Also known as an "eligible community." A community in which the administrator has authorized the sale of flood insurance.

Permanent Work - Restorative work that must be performed through repairs or replacement to restore an eligible facility on the basis of its predisaster design and current applicable standards.

Permeability - The property of soil or rock that allows water to pass through it.

Pier - An upright support member of a building, with a height limited to a maximum of three times its least lateral dimension. It is designed and constructed to function as an independent structural element in supporting and transmitting building and environmental loads to the ground.

Pile - Upright support members of a building, usually long and slender in shape, driven into the ground by mechanical means and primarily supported by friction between the pile and the surrounding earth. Piles often cannot act as individual support units, and require bracing to other pilings.

Pineapple Express - The southerly branch of the jet stream typically extends from near Hawaii to the Pacific Northwest, tapping into the supply of subtropical moisture. (15º N approximately 5º latitude south of Hawaii).

Post - Long upright support units for a building, set in predug holes and back-filled with compacted material. Each post usually requires bracing to other units. They are also known as *columns*, although they are usually made of wood.

Predisaster Design - The size or capacity of a facility as originally designed and constructed or subsequently modified by changes or additions to the original design. It does not mean the capacity at which the facility was being used at the time the major disaster occurred if different from the most recent designed capacity.

Preliminary Damage Assessment - A term used to refer to a damage assessment performed by federal, state, and local representatives in disaster situations clearly beyond the recovery capabilities of state and local governments.

Preparedness - Preparedness is planning how to respond in case an emergency or disaster occurs and working to increase resources available to respond effectively.

Preserve - To prevent alterations to natural conditions and to maintain the values and functions that operate the floodplains or wetlands in their natural states.

Presidential Disaster Declaration - The official or formal approval given by the President of the United States that authorizes the release of federal disaster assistance to communities. Section 401 of Public Law 93-288, as amended by Public Law 100-707, the Robert T. Stafford Relief and Emergency Assistance Act of 1988, specifies the state requirements to obtain a presidential declaration. As part of the requirements, the local and state governments must have exhausted their resources.

Primary Frontal Dune - A continuous or nearly continuous mound or ridge of sand with relatively steep seaward and landward slopes immediately landward and adjacent to the beach, and subject to erosion and overtopping from high tides and waves during major coastal storms. The inland limit of the primary frontal dune occurs at the point where there is a distinct change from a relatively steep slope to a relatively mild slope.

Principally Above Ground - At least 51 percent of the actual cash value of the structure, less land value, is above ground.

Private Nonprofit Facility - Private, nonprofit facilities, such as educational, utility, emergency, medical, rehabilitational, and temporary or permanent custodial care facilities (including those for the aged and disabled), or other private, nonprofit facilities that provide essential services of a governmental nature to the general public, and facilities on Indian reservations as defined by the President. For the purposes of the Stafford Act - any nongovernmental agency or entity that currently has: an effective ruling letter from the U.S. Internal Revenue Service granting tax exemption under Sections 501 (c), (d), or (e) of the Internal Revenue Code of 1954; or satisfactory evidence from the state that the organization or entity is a nonprofit one organized or doing business under state law.

Private Nonprofit Organization - Any nongovernmental agency or entity that currently has: an effective ruling letter from the U.S. Internal Revenue Service, granting tax exemption under Sections 501(c), (d), or (e) of the Internal Revenue Code of 1954; or satisfactory evidence from the state that the nonrevenue producing organization or entity is a nonprofit one organized or doing business under state law.

Probable Maximum Flood - The most severe flood that may be expected from a combination of the most critical meteorological and hydrological conditions that are reasonably possible in the drainage basin. It is used in designing high-risk flood protection works and in siting structures and facilities that must be subject to almost no risk of flooding. The probable maximum flood is usually much larger than the 100-year flood.

Profile - A graph or plot of the water surface elevation against distance along a channel. Also termed "flood profile" if drawn for a specific flood or level of flooding.

Public Assistance (PA) - Supplementary federal assistance provided under the Stafford Act to state and local governments or certain private, nonprofit organizations, other than assistance for the direct benefit of individuals and families.

Public Entity - An organization formed for a public purpose whose direction and funding are provided by one or more political subdivisions of the state.

Public Facility - Includes the following facilities owned by a state or local government:

- Any flood control, navigation, irrigation, reclamation, public power, sewage treatment and collection, water supply and distribution, watershed development, or airport facility;
- Any non-federal-aid street, road, or highway;
- Any other public building, structure, or system, including those used for educational, recreational, or cultural purposes; and
- Any park.

Public Law 93-288, As Amended - The Robert T. Stafford Emergency Assistance and Disaster Relief Act, as amended by P.L. 100-707. Includes Section 404-Hazard Mitigation Grant Program. Section 406-Public Assistance, Infrastructure. Section 409-Hazard Mitigation Planning. Section 411-Individual Assistance. Section 417-Fire Suppression.

Recurrence Interval - A statistical expression of the average time between floods, equaling or exceeding a given magnitude (see flood frequency).

Reference Feature - The receding edge of a bluff or eroding frontal dune, or, if such a feature is not present, the normal high-water line or the seaward line of permanent vegetation if a high-water line cannot be identified.

Regional Director (RD) - A director of a regional office of FEMA, or his/her designated representative. As used in the Stafford Act, Regional Director also means the Disaster Recovery Manager who has been appointed to exercise the authority of the Regional Director for a particular emergency or major disaster.

Regulatory Flood Datum (RFD) - Established plane of reference from which elevation and depth of flooding may be determined for specific locations of the floodplain. It is the base flood plus a freeboard factor of safety established for each particular area to compensate for the many unknown and incalculable factors that could contribute to greater flood heights than that computed for a base flood.

Regulatory Floodplain - The portion of the floodplain subject to floodplain regulations (usually the floodplain inundated by the one-percent chance flood).

Regulatory Floodway - The portion of the floodplain needed to discharge the 100-year flood without increasing the flood elevation by more than a designated height, usually one-foot.

Reservoir - A natural or artificially created pond, lake, or other space used for storage, regulation, or control of water. May be either permanent or temporary.

Response - The efforts to minimize the risks created in an emergency by protecting the people, the environment, and property, and the efforts to return the scene to normal, pre-emergency conditions.

Restore - To re-establish a setting or environment in which the natural functions can operate again.

Riprap - Broken stone, cut stone blocks, or rubble that is placed on slopes to protect the slopes from erosion or scouring caused by flood waters or wave action.

Risk - A measure of the probability that damage to life, property, and/or the environment will occur if a hazard manifests itself; this measure includes the severity of anticipated consequences to people.

Risk Analysis - Assesses probability of damage (or injury) and actual damage (or injury) that might occur, in light of the hazard analysis and vulnerability analysis. Some planners may choose to analyze worst-case scenarios.

Risk Area - An area considered likely to be affected by a natural or technological hazard. Risk areas are based on recommended isolation distances, identifiable land features, etc.

Risk Management - Refers to a decision making process that involves such considerations as risk assessment, technological feasibility, economic information about costs and benefits, statutory requirements, public concerns, and other factors.

Risk Premium Rates - Rates established by the administrator pursuant to individual community studies and investigations that are undertaken to provide flood insurance in accordance with section 1307 of the Act and the accepted actuarial principles. Risk premium rates include provisions for operating costs and allowances.

Riverine - Relating to, formed by, or resembling a river (including tributaries), stream, brook, etc.

Riverine Flooding - Flooding related to or caused by a river, stream, or tributary overflowing its banks.

Runoff - The portion of precipitation that is not intercepted by vegetation, absorbed by the land surface, or evaporated, and thus flows overland into a depression, stream, lake, or ocean. (Runoff called “immediate subsurface runoff” also takes place in the upper layers of the soil.)

Sand Dunes - Naturally occurring accumulations of sand in ridges or mounds landward of the beach.

Scouring - The erosion or washing away, of slopes or soil by velocity waters.

Second Layer Coverage - An additional limit of insurance coverage equal to the amounts made available under the Emergency Program, and made available under the Regular Program.

Secondary Cost - The cost associated with floodproofing activities, other than providing the basic floodproofing features that are necessary to prevent a structure from being damaged by flooding.

Secondary Impacts - Hazards or problems created by another disaster. For example, secondary hazards from floods include levee failures; the rapid formation of alluvial fans; flood-induced landslides, debris flows, and mudflows.

Section 404 - Section of the Stafford Act authorizing the Hazard Mitigation Grant Program to provide funding for cost- effective, hazard mitigation measures.

Section 409 - Section of the Stafford Act enacted to encourage identification and mitigation of hazards at all levels of government. Section 409 requires the identification and evaluation of mitigation opportunities as a condition for receiving federal disaster assistance.

Section 409 Hazard Mitigation Plan - The hazard mitigation plan required under Section 409 as a condition of receiving federal disaster assistance.

Sediment - Fine soil and other material that settle to the bottom of streambeds.

Seepage - The passage of water or other fluid through a porous medium, such as the passage of water through an earth embankment or masonry wall.

Servicing Company - A corporation, partnership, association, or any other organized entity that contracts with the Federal Insurance Administration to service insurance policies under the NFIP for a particular area.

Sheet Flooding - Floods created when melting snow and rainfall spread and accumulate over large areas of land still frozen below the surface.

Shelter - A facility to house, feed, and care for persons evacuated from a risk area for periods of one or more days. For the risk areas, the primary shelter and the reception center are usually located in the same facility.

Shore/ Streambank Erosion - The process through which gravity, wind, and water erodes the banks of streams and shorelands.

Sixty-Year Setback - A distance equal to 60 times the average annual long-term recession rate at a site, measured from the reference feature.

Slab on Grade - A structural design where the first floor sits directly on a poured concrete slab that sits directly on the ground.

Slope Stability - The relative resistance of a slope to erosion.

Snowpacks - Accumulations of snow. Usually associated with year round water availability.

Special Flood Hazard Area (SFHA) - Areas in a community that have been identified as having a one-percent or greater chance of flooding in any given year. A one-percent-probability flood also is known as the 100-year flood or the base flood. Special Flood Hazard Areas are usually designated on the Flood Hazard Boundary Map (FHBM) as Zone A. After detailed evaluation of local flooding characteristics, the Flood Insurance Rate Map (FIRM) will refine this categorization into Zones A, AE, AH, AO, A1-30, VE, and V1-30.

Special Needs Population - In case of a public evacuation, certain groups within a hazard area may require special transportation or protective provisions due to special needs or sensitive industrial operations. Examples of such groups are the staff and inhabitants of schools and day care centers; nursing homes; hospitals; retirement centers; public utilities; large agricultural farms; correctional institutions; facilities for developmentally disabled and physically challenged persons; special industrial plants; tourists; homeless; and individuals with no transportation. Local emergency plans should have reference for evacuation routes and potential shelter sites.

Stafford Act - Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-707, signed into law November 23, 1988; amended, the Disaster Relief Act of 1974, PL 93-288.

Standard Flood Insurance Policy - The flood insurance policy issued by the Federal Insurance Administrator, or an insurer following an arrangement with the Administrator, following federal statutes and regulations.

Standard Project Flood - A term used by the U.S. Army Corps of Engineers to designate a flood that may be expected from the most severe combination of meteorological and hydrological conditions which are considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extremely rare combinations. The peak flow for a standard project flood is generally 40 to 60 percent of the probable maximum flood for the same location.

Start of Construction - Includes substantial improvement, and means the date the building permit was issued, provided the actual start of construction, repair, reconstruction, placement, or other improvement was within 180 days of the permit date. The actual start means the first placement of permanent construction of a structure on a site, such as the pouring of slab or footings, any work beyond the stage of excavation, or the placement of a manufactured home on a foundation. Permanent construction does not include land preparation, such as clearing, grading, and filling; the installation of streets or walkways; excavation for a basement; footings, foundations, or the erection of temporary forms; or the installation of accessory buildings on the property, such as garages or sheds not occupied as dwelling units and not part of the main structure.

State - Any state of the United States plus the District of Columbia, Puerto Rico, the Virgin Islands, Guam, American Samoa, the Trust Territory of the Pacific Islands, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, or the Republic of the Marshall Islands.

State Coordinating Agency - The agency of the state government designated by the governor of the state at the request of the administrator to coordinate the flood insurance program in that state.

State Coordinating Officer (SCO) - The person appointed by the governor to act in cooperation with the Federal Coordinating Officer to administer disaster recovery efforts.

State Emergency Response Commission - The state planning group designated by the Superfund Amendments and Reauthorization Act of 1986, Title III statues as the state coordinating body for hazardous materials activities.

State Hazard Mitigation Officer (SHMO) - The representative of state government who serves on the Hazard Mitigation Survey Team and Interagency Hazard Mitigation Team, and who is the primary point of contact with FEMA, other federal agencies, and local units of government in the planning and implementation of post-disaster mitigation activities.

State Hazard Mitigation Team - Composed of key state agency representatives, local units of government, and other public or private sector bodies or agencies, the purpose of the State Hazard Mitigation Team is to evaluate hazards, identify strategies, coordinate resources, and implement measures that will reduce the vulnerability of people and property to damage from hazards.

Stile - A set of stairs to allow access over an obstruction, such as a floodwall.

Stormwater - Rainwater that runs off impermeable surfaces or travels through natural or artificial drainage systems.

Stormwater Flooding - Flooding that occurs when runoff from rainfall overwhelms the drainage system of an area. Stormwater flood flows tend to concentrate in developed areas, drainage systems, and low-lying areas. An increase in impermeable surfaces can increase the likelihood and severity of stormwater flooding.

Stream - A body of water flowing in a natural surface channel. Flow may be continuous or only during wet periods. Streams that flow only during wet periods are termed “intermittent streams.”

Stream Gages - Tools to measure the water level in streams. Stream gages can provide warning of the accumulation of floodwaters. Some are automated with sophisticated telemetry. Others must have an individual read the gage physically.

Structural Floodplain Management Measures - The physical or engineering measures employed to modify the way floods behave, such as dams, dikes, levees, channel enlargements, and diversions.

Structural Mat Slab - The concrete slab of a building that includes structural reinforcement to help support the building’s structure.

Structure - A walled and roofed building, including a gas or liquid storage tank, that is principally above ground and affixed to a permanent site, as well as a mobile home on foundation.

Subdivision Regulations - Ordinances or regulations governing the subdivision of land with respect to such things as adequacy and suitability of building sites, utilities, and public facilities.

Subgrant - An award of financial assistance under a grant by a grantee to an eligible subgrantee.

Subgrantee - The government or other legal entity to which a subgrant is awarded and which is accountable to the grantee for the use of the funds provided.

Subpart M, Hazard Mitigation Planning - 44 CFR Part 206, Subpart M—prescribes the actions and procedures for implementing Section 409 of the Stafford Act.

Subpart N, Hazard Mitigation Grant Program - 44 CFR Part 206, Subpart N—provides guidance on the administration of hazard mitigation grants made under provisions of Section 404 of the Stafford Act.

Subsidence - Sinking of the land surface, usually due to withdrawals of underground water, oil, or minerals.

Subsidized Rates - The rates that involve subsidization by the federal government to encourage the purchase of flood insurance on existing structures at reasonably affordable costs.

Substantial Damage - Damage of any origin sustained by a structure whereby the cost of restoring the structure to its pre-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.

Substantial Improvement - Any repair, reconstruction, or other improvement of a structure or facility, that has been damaged in excess of, or the cost of which equals or exceeds, 50 percent of the market value of the structure or placement costs of the facility (including all "public facilities" as defined in the Stafford Act) either: (a) before the improvement or repair is started; or (b) if the structure has been damaged, and is being restored, before the damage occurred. The term does not, however, include either (1) any project for improvement of a structure to comply with existing state or local health sanitary, or safety code specifications that are solely necessary to assure safe living conditions, or (2) any alteration of a structure listed on the National Register of Historic Places or a state inventory of historic places.

Superfund Amendments And Reauthorization Act Of 1986 (Sara) - Title III of SARA includes detailed provisions for community emergency planning for fixed chemical facilities. Law requires establishment of state and local planning organizations to conduct emergency planning for hazardous materials incidents. Public Law 99-499. 38.52.040 RCW and 118-40 WAC.

Takings - Acquisition of private property by a local jurisdiction without reasonable compensation.

Temporary Housing - Temporary accommodations provided by the federal government to individuals or families whose homes are made unlivable by an emergency or a major disaster.

Thirty-Year Setback - A distance equal to 30 times the average annual long- term recession rate at a site, measured from the reference feature.

Title III - A major section of the Superfund Amendments and Reauthorization Act entitled the *Emergency Planning and Community Right-to-Know Act of 1986*.

Topography - The physical features of a place or region.

Tributary - A river or stream flowing into a larger river or stream.

Tsunami - A tsunami is a series of giant sea waves. These are generated by an earthquake or volcanic action on the ocean floor or near coastal areas. Tsunami waves can travel more than 500 miles per hour through open seas and build to heights of 100 feet or more when approaching the shoreline.

Underseepage - Seepage along the bottom of a structure, floodwall, or levee or through the layer of earth beneath it.

Urban Floods - Flooding of streams or impermeable sites typical of urban areas.

Utility - Buildings, structures, or systems of energy, communication, water supply, sewage collection and treatment, or other similar public service facilities.

Variance - A grant of relief by a community to a person from the terms of a floodplain management regulation permitting construction in a manner otherwise prohibited by the regulation and where specific enforcement would result in unnecessary hardship. Specific requirements may vary depending on state zoning, enabling legislation, or community ordinances.

Venting - A system designed to allow floodwaters to enter an enclosure, usually the interior of foundation walls, so that the rising water does not create a dangerous differential in hydrostatic pressure. This is usually achieved through small openings in the wall, such as a missing or rotated brick or concrete block, or small pipe.

Voluntary Organization - Any chartered or otherwise duly recognized tax-exempt local, state, or national organization or group that has provided or may provide needed services to the states, local governments, or individuals in coping with an emergency or a major disaster.

Vulnerability - Risk expresses the likelihood of an event such as a flood occurring. This definition is in contrast to that of vulnerability, also used throughout this document. Vulnerability describes something's exposure to a threat. The distinction between these terms is important. A home located in a 500-year floodplain could be considered vulnerable to a 500-year flood although the risk of that flood happening may be low. The risk of a park located in a floodplain being struck by a flood may be quite high, but the park would not be considered vulnerable to damage because the flood's effect upon it would be small.

Vulnerability Analysis - Identifies what is susceptible to damage. Should provide information on extent of the vulnerable zone; population, in terms of size and types that could be expected to be within the vulnerable zone; private and public property that may be damaged, including essential support systems and transportation corridors; and environment that may be affected, and impact on sensitive natural areas and endangered species.

Water Surface Elevation - The heights, usually in relation to mean sea level, reached by flows of various magnitudes and frequencies at pertinent points in the floodplain.

Water Table - The uppermost zone of water saturation in the ground.

Watercourse - A natural or artificial channel in which a flow of water occurs either continually or intermittently.

Watershed - An area that drains to a single point. In a natural basin, this is the area contributing flow to a given place or stream.

Wetland - "Wetlands" means lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands have one or more of the following three attributes: a) At least periodically, the land supports predominantly hydrophytes; b) the substrate is predominantly undrained hydric soil; and c) the substrate is nonsoils and is saturated with water or covered by shallow water at some time during the growing season of each year.

Windward - The side from which the wind blows. A western aspect (or exposure) would be the windward slope for a wind blowing from the west.

Zone of Imminent Collapse - An area subject to erosion adjacent to the shoreline of an ocean, bay, or lake and within a distance equal to 10 feet plus five times the average annual long-term erosion rate for the site, measured from the reference feature.

Zoning Ordinance - An ordinance under the state or local government's police power that divides an area into districts and, within each district regulates the use of land and buildings, height, and bulk of buildings or other structures, and the density of population.

APPENDIX B - ACRONYMS

ARC	American Red Cross
BFE	Base Flood Elevation
CCA	Comprehensive Cooperative Agreement
CDBG	Community Development Block Grant
CDL	Community Disaster Loan
CFR	Code of Federal Regulations
CHIP	Comprehensive Hazard Identification Program
DAE	Disaster Assistance Employee
DAP	Disaster Assistance Programs
DCTED	Department of Community Trade and Economic Development
DFCO	Deputy Federal Coordinating Officer
DFO	Disaster Field Office
DNR	Department of Natural Resources
DOC	Department of Commerce
DoD	Department of Defense
DOE	Department of Energy
DoED	Department of Education
DOL	Department of Labor
DOT	Department of Transportation
DPIG	Disaster Preparedness Improvement Grant
DRM	Disaster Recovery Manager
DRO	Disaster Recovery Operations
DSR	Disaster Survey Report
EAS	Emergency Alert System
EMI	Emergency Management Institute
EO	Executive Order
EOC	Emergency Operating Center
EOP	Emergency Operations Plan
EPA	Environmental Protection Agency
ERT	Emergency Response Team
FBFM	Flood Boundary Floodway Map
FCO	Federal Coordinating Officer
FEMA	Federal Emergency Management Agency
FHMO	Federal Hazard Mitigation Officer
FHWA	Federal Highway Administration
FIA	Federal Insurance Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FPM	Flood Plain Management
GAR	Governor’s Authorized Representative
GSA	General Services Administration

HHS	Department of Health and Human Services
HM	Hazard Mitigation
HMA	Hazard Mitigation Assistance (Program)
HMGP	Hazard Mitigation Grant Program
HMO	Hazard Mitigation Officer
HMST	Hazard Mitigation Survey Team
HUD	Department of Housing and Urban Development
IA	Individual Assistance
IFG	Individual and Family Grant Program
IHMT	Interagency Hazard Mitigation Team
LHMO	Local Hazard Mitigation Officer
MOU	Memorandum of Understanding
NETC	National Emergency Training Center
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
NRC	Nuclear Regulatory Commission
OMB	Office of Management and Budget
PA	Public Assistance
PAO	Public Assistance Officer
PDA	Preliminary Damage Assessment
PIO	Public Information Officer
PL	Public Law
RCW	Revised Code of Washington
SCO	State Coordinating Officer
SHMO	State Hazard Mitigation Officer
SHMT	State Hazard Mitigation Team
SLPS	State and Local Programs and Support
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
VA	Veterans Administration
VOAD	Voluntary Organizations Active in Disasters
WAC	Washington Administrative Code
WSDOT	Washington State Department of Transportation
WSEM	Washington State Emergency Management

APPENDIX C - LIST OF REFERENCES

Applied Technology Council. (1989). Procedures for Post Earthquake Safety Evaluation of Buildings (ATC 20). Redwood City, CA: Author.

Department of Community Development. (1991). A Policy Plan for Improving Earthquake Safety in Washington: Fulfilling Our Responsibility (Seismic Safety Advisory Committee). Olympia, WA: Department of Community, Trade and Economic Development.

Department of Community Development. (1993). Washington State Flood Damage Reduction Plan. Olympia, WA: Author.

Department of Community Development & Department of Natural Resources. (1994). Washington Wildfire Mitigation Plan. Olympia, WA: Author

Federal Emergency Management Agency. (1994). Reducing the Risks of Nonstructural Earthquake Damage: A Practical Guide (FEMA Publication 74). Washington D.C.: U.S. Government Printing Office.

Federal Emergency Management Agency. (1995). National Mitigation Strategy, Partnerships for Building Safer Communities. Final Draft.

Federal Emergency Management Agency. (1997). Hazard Mitigation Survey Team Report, 1996-97 Winter Storms (FEMA Region X). Bothell, WA: Author.

Federal Emergency Management Agency Region X. (1981). Interagency Flood Hazard Mitigation Report in Response to the May 21 Disaster Declaration (Report DR-623-WA). Bothell, WA: Author.

Federal Emergency Management Agency, Region X. (1996). Major Findings From Field Evaluation of Flood-Damaged Mobile/Manufactured Homes in DR-1100, Washington State, February 1996 Flood Event (FEMA Region X report). Bothell, WA: Author.

Galloway, Gerald E. (1994). Sharing the Challenge: Floodplain Management into the 21st Century, (Report of the Interagency Floodplain Management Review Committee to the Administration Floodplain Management Task Force). Washington D.C.: U.S. Government Printing Office.

Greenhorne, O'Mara, & Federal Emergency Management Agency. (1996). Manufactured Home Foundations, A Summary of Current Studies.

International City Management Association. (1991). Emergency Management: Principles and Practice for Local Government.

Insurance Institute for Property Loss Reduction (Now called Institute for Business and Home Safety). (1997). Natural Hazard Mitigation Insights, Ice Dams (No. 6, ISSN 1089-6058). Washington, D.C.: Author.

King County Surface Water Management. (1993). King County Flood Hazard Reduction Plan. Seattle, WA: Author.

Rivers, Trails and Conservation Assistance Program and the Association of State Floodplain Managers. (????). How We Can Get From This To This With Multi-Objective Management (Flyer).

Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988. Section 409, P.L. 93-288 as amended.

Staff. (1997, September – October). Warning buoys to aid tsunami prevention. Emergency Responder, p. 1.

State of Washington Department of Community Development & Department of Natural Resources. (1992). Firestorm '91 and Wind Mitigation Survey Report (Report DR-922-WA). Olympia, WA: Author.

TriData Corporation. (1998). Department of Natural Resources Fire Program Review: F. Prevention and Mitigation (Department of Natural Resources Internet Home Page). Olympia, WA: Author.

U.S. Army Corps of Engineers, Seattle District. (1997). Post Event Report: Winter Storm of 1996-97 Federal Disaster DR 1159 (U.S. Army Corps of Engineers). Seattle, WA: Author.

U.S. Department of the Interior. (1998) Creators and Destroyers, Volcanoes, Lesson 2. Denver, CO: USGS.

U.S. Geological Survey, Cascades Volcano Observatory. (1997). Lahar Detection at Mount Rainier: A Framework for Decision Making. Vancouver, WA: Author.

United States Geological Survey. (1991). National Water Summary 1988-89—Hydrologic Events and Floods and Droughts (United States Geological Survey, Water-Supply Paper 2375). Washington, DC: U.S. Government Printing Office.

Washington State Community, Trade and Economic Development. (1994). Washington State Wind Mitigation Report and Action Plan (Report DR-981-WA). Olympia, WA: Author.

Washington State Department of Ecology. (1993). Washington State Flood Damage Reduction Plan. Olympia, WA: Author.

Washington State Emergency Management Council, Seismic Safety Subcommittee. (1997). Earthquake Safety in Washington State: A Progress Report on Activities for the Period 1992-1997. Olympia, WA: Washington State Library.

Washington State Emergency Management Division & Federal Emergency Management Agency Region X. (1996). Hazard Mitigation Early Implementation Strategy for the 1995 Washington State Flood, (Report DR-1079-WA). Bothell, WA: Author

Washington State Emergency Management Division & Federal Emergency Management Agency Region X. (1980). State of Washington Hazard Mitigation Report for the Eruption of Mt. St. Helens, (Report DR-623-WA). Bothell, WA: Author

Washington State Emergency Management Division & Federal Emergency Management Agency Region X. (1996). Hazard Mitigation Early Implementation Strategy for the 1995 Washington State Flood (Report DR-1079-WA). Bothell, WA: Author.

Washington State Emergency Management Division & Federal Emergency Management Agency Region X. (1996). Hazard Mitigation Early Implementation Strategy for the 1996 Washington State Flood (Report DR-1100-WA). Bothell, WA: Author.

Washington State Emergency Management Division & Federal Emergency Management Agency Region X. (1997). Hazard Mitigation Survey Team Report for the 1996-1997 Washington Winter Storms (Report DR-1152-WA, DR-1159-WA and DR-1172-WA). Bothell, WA: Author.

Washington State Executive Water Emergency Committee. (1988). Initial Drought Action Program for 1988. Olympia, WA: Author.

Washington State Fire Defense Board. (1997). October Meeting Minutes. Mead, WA: Author.

Washington State Insurance Commissioner. (1997). Washington Insurance Commissioner Fact Sheet. Olympia, WA: Author.

Washington State Military Department, Emergency Management Division. (1996). Washington State Comprehensive Emergency Management Plan. Tacoma, WA: Author.

Washington State Military Department, Emergency Management Division. (2000). State of Washington Hazard Identification Vulnerability Analysis. Tacoma, WA: Author.

Washington State Office of Financial Management. (1996). 1996 Population Trends (Population Forecast by Age, Sex, and Race/Ethnicity for the State of Washington: 1995-2000). Olympia, WA: Author.

Washington State Office of Financial Management. (1997). 1996 Population Trends (OFM Internet Homepage). Olympia, WA: Author.

Washington State Office of Financial Management. (1997). 1997 Population Trends (Population Forecast by Age, Sex, and Race/Ethnicity for the State of Washington: 1995-2000). Olympia, WA: Author.

Washington Water Power. (1997). Ice Storm ‘96 Overview. Spokane, WA: Author.

APPENDIX D – OTHER DOCUMENTS ADDRESSING MITIGATION STRATEGIES

The following documents contain mitigation strategies or statutes that complement the *Washington State Hazard Mitigation Strategy*.

1999 Fire Services Resource Mobilization Plan – (RCW 38.54)
The "Mobilization Plan" is an appendix to ESF4 (firefighting) of the *Comprehensive Emergency Management Plan*. The plan is used for state mobilization of fire resources in Washington State in response to major fires or other disasters.
Lead Agency: Washington State Patrol

Aquatic Lands Law – (Title 79.90 – 96 and RCW 79.90.550-560)
The purpose of the Aquatic Lands Law is to exercise the state's ownership interest over submerged lands for the benefit of the public trust. The Department of Natural Resources' (DNR) primary jurisdiction derives from its exercise of state ownership of the subtidal bedlands from the line of lower low tide out to three miles, and of the bed of navigable rivers. State ownership includes ownership of all valuable materials on or under such bedlands, including sand and gravel. State ownership also includes proprietary jurisdiction over the use of placement of structures on such lands. DNR jurisdiction comes to bear in the case of any proposal for removal of sand or rock from stae-owned bedlands for use in a coastal erosion-related project, or for any proposal to place materials on state-owned bedlands for such purpose. DNR jurisdiction does not extend to the actual placement of materials on coastal intertidal areas managed by State Parks, or on land above high tide.

Clean Water Act – Section 404 and 401 (Public Law 92-212, 33 U.S.C. Section 1251 et seq)
The primary goal of the Clean Water Act (CWA) is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The Washington State Department of Ecology (Ecology) manages the state program. Section 401 requirements pertain to any activity that requires a federal permit and that may result in a discharge to state water. Section 401 is implemented through a certification process and ensures that federally permitted activities comply with the federal CWA, state water quality laws, and any other appropriate state laws. Section 404 is specifically directed towards regulating discharge of dredged or fill material into waters of the United States. It provides for government and public review and comment on projects that alter or destroy waters of the United States by filling or disposal of dredge spoil. A permit program is used administer the provisions of Section 404. The U.S. Army Corps of Engineers issues or denies permits.

Coastal Barrier Resources Act of 1982 – (16 U.S.C. Sections 3501-3510, amended 1990)
This act seeks to protect undeveloped coastal barrier island environments by denying federal subsidies for development in hazard-prone and ecologically significant coastal areas, designated for protection in the Coastal Barrier Resources System (CBRS).

Coastal Zone Management Act (CZMA) of 1972 as amended – (16 U.S.C. 1271 et seq.) (RCW 90.58.300)
The CZMA, first passed in 1972, is the single overarching federal law dealing with planing for the nation's coastal regions. Its basic aim is to encourage federal/state collaboration using federal incentives in the form of matching grants. Sections 305 and 306 provide funds for the preparation

and implementation of state coastal zone management plans. The act also provides for consistency between state and federal coastal plans, and federal actions must comply with approved state plans. The national Oceanic and Atmospheric Administration (NOAA), an agency of the U.S. Department of Commerce administers the act.
The primary purpose of the CZMA is to: "preserve, protect, develop, and where possible, to restore or enhance, the resources of the nation's coastal zone for this and succeeding generations." The 1980 amendments to the act added hazard management as one of nine new elements in state coastal zone management plans. The 1990 reauthorization specified the mitigation of natural hazards including sea-level rise.

Washington State's coastal zone generally includes all the shorelines of the state under the Shoreline Management Act in the fifteen coastal counties which either border on the Pacific Ocean (including Wahkiakum) or on the Puget Sound. This federal law is implemented through the state's Coastal Zone Management Program. That program includes the Shoreline Management Act, the state Environmental Policy Act, the Ocean Resources Management Act, the Clean Water Act and the Clean Air Act.
Lead Agency: Washington State Department of Ecology.

Drought Contingency Plan, Annex Z2, January 1992

Earthquake Hazards Reduction Act of 1977

Earthquake Standards for Construction – (RCW 70.86)

Executive Order 12699, Seismic Safety of Federal and Federally Assisted or Regulated new Building Construction (Resistant Buildings)
Requires that new construction of federal buildings must comply with appropriate seismic design and construction standards.

Flood Control Assistance Account Program – (RCW 86.26.050, WAC173-145-010)
Provides that county and other municipal corporations responsible for flood control maintenance may apply to the Department of Ecology for financial assistance for the preparation of comprehensive flood control management plans and for flood control maintenance projects as described in RCW 86.26.105. The department determines priorities and allocates available funds from the flood control assistance account program (FCAAP) among those counties applying for assistance, and adopts regulations establishing the criteria by which such allocations shall be made. Criteria is based upon proposals that are likely to bring about public benefits commensurate with the amount of state funds allocated.

Flood Plain Management Act (RCW 86.16.041)
Purpose is to avoid direct or indirect support of floodplain development and to minimize harm to floodplains and wetlands. Federal decision-makers are obligated to comply with these orders, accomplished through an eight-step decision-making process. The Flood Plain Management Act prohibits any new residential developments (or substantial improvements to existing residences) in designated floodways. Floodways are considered the most dangerous areas of a floodplain, and the goal of the prohibition is to save lives and prevent repetitive damage to buildings.

The 1999 legislature changed the code to allow repairs or replacement of existing farmhouses located on commercial farm sites within a designated floodway under certain conditions.
Lead Agency: Department of Ecology

Floodplain Management, Executive Order 11988 – (42 F.R. 26951 et seq.)

Forest Practices Act – (RCW 76.09)(WAC Title 222)
The forest practices permit process was revised in 1999 to prevent landslides. The most hazardous areas must be identified and operation there severely restricted. The Washington State Forest Practices Act requires preservation of uncut trees across the landscape to provide visual, physical, wildlife, and fisheries habitat buffers. Consequently, the Forest Services Act works to prevent erosion of streams and aids in the prevention of landslides. Lead agency: Department of Natural Resources

Growth Management Act – (RCW 36.70A)
The legislature found that uncoordinated and unplanned growth posed a threat to the environment, sustainable economic development, and the health, safety, and high quality of life enjoyed by residents of the state. The legislature concluded "it is in the publics interest that citizens, communities, local government, and the private sector cooperate and coordinate with one another in comprehensive land use planning."

Integrated Fixed Facility Radiological and Chemical Protection Plan, January 1997
The plan provides a one source document for the three fixed facilities, six Washington Counties, and multiple state and federal agencies that are directly involved in emergency planning for these facilities.

Memorandum of Agreement, Coordinating Flood Planning in Washington State
The purpose of this agreement is to establish a link between the flood damage reduction planning requirements and processes administered by the Departments of Community Trade and Economic Development (CTED) and Ecology. The signatory agencies seek to improve the flood damage reduction planning process by coordinating planning requirements to ensure that local flood damage reduction plans that meet the requirements of Ecology's Flood Control Assistance Account Program, will also meet the requirements of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. This agreement forms the basis for the Washington State position in negotiating with the U.S. Federal Emergency Management Agency regarding hazard mitigation funding for flood projects. This agreement should ensure that a single local plan, when approved by CTED and Ecology, will meet state and federal requirement for a variety of project funds.

Memorandum of Understanding: Emergency Work in Watercourses (Jan. 1997) – (RCW 90.50, 90.48, 75.08.012, 75.20.100, 36.32.280, 36.32.290, 36.32.300, 38.52, 35.32A.060, 35.33.081, 35.33.91)
The Washington State Department of Fish and Wildlife, Washington Military Department, Emergency Management Division, Washington State Association of Counties, Association of Washington Cities, Washington State Department of Ecology and the Washington State Department of Transportation are signatories of this MOU. Counties and cities have authority under various sections of the RCW to work in watercourses for the purpose of preventing floods that may threaten life and property or cause damage to public or private property. The RCW also charges the

Department of Fish and Wildlife to preserve, protect, perpetuate, and manage the fish and wildlife resources of the state.

The signatory agencies share a common interest in prevention of habitat loss through damage by flooding and future land development. The intent of the procedures outlined in the MOU are to mutually cooperate and establish procedures for emergency flood control work when the normal permit processes cannot reasonably be utilized. Paragraph III of the MOU addresses Emergency Flood Control Work Procedures and paragraph IV addresses Flood Hazard Reduction.

The county and city authorities and the Department of Fish and Wildlife authorities are based on different purposes that sometimes result in potential conflicts among those involved. Consequently, procedures have been developed in this MOU that can be used as an alternative to a legislative or litigated resolution of differences in statutes for accomplishment of work by public operating agencies, in the protection of natural resources and public facilities.

National Environment Policy Act of 1969– (NEPA) (42 U.S.C. 4321-4347)
"NEPA is the basic national charter for protection of the environment. It establishes policy, sets goals, and provides means for carrying out the policy. The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality."

The State Environmental Policy Act (SEPA) – (RCW 43.21)
SEPA is intended to ensure the environmental values are considered during decision-making by state and local agencies. SEPA provides policies, goals, and procedures intended to ensure that agencies consider the environmental impacts related to their decision on proposals that may have a significant impact on the environment. When SEPA was adopted, the legislature identified four primary purposes:

1. "To declare a state policy which will encourage productive and enjoyable harmony between man and his environment;
2. to promote efforts which will prevent or eliminate damage to the environment and biosphere;
3. and stimulate the health and welfare of man; and
4. to enrich the understanding of the ecological systems and natural resources important to the state and nation."

National Flood Insurance Plan (NFIP)
The NFIP is a FEMA program based on several pieces of legislation that originated with the National Flood Insurance Act of 1968. The program deals with both riverine and coastal floodplains. The NFIP is a voluntary program, but flood insurance is available only in communities with an approved floodplain management program in effect.

Policy Plan for Improving Earthquake Safety in Washington, December 1, 1991
Lists strategies to mitigate earthquake damage.

Protection of Wetlands, Executive Order 11990 – (42 F.R. 26961 et. seq.)
Purpose is to avoid direct or indirect support of floodplain development and to minimize harm to floodplains and wetlands. Federal decision-makers are obligated to comply with these orders, accomplished through an eight-step decision-making process.

State Building Code – (RCW 19.27)
The purpose of the building code is to promote the health, safety and welfare of the occupants or users of buildings and structures and the general public by the provision of building codes throughout the state. The code requires minimum performance standards and requirements for construction and construction materials, consistent with accepted standards of engineering, fire and life safety.

The Hydraulic Code of 1949 – (RCW 75.20.100-160, 220-110 WAC)
The state Hydraulic Code, administered by the Washington Department of Fish and Wildlife (WDFW), is intended to protect fish life and habitat. The code applies to activities in and near the ordinary high water line of all marine and fresh waters of the state. Approval of the WDFW is required before construction or other work that will use, divert, obstruct, or change the natural flow or bed of any state waters. The permit must be in compliance with the State Environmental Policy Act.

The Ocean Resources Management Act – (RCW 43.143.005 – 43.143.902)
Enacted in 1989 and amended in 1997, this chapter of the RCW articulates policies and establishes guidelines for the exercise of state and local management authority over Washington's coastal waters, seabed, and shorelines. This statute addresses the coastal and ocean natural resources within three miles of the state's coastline, defined here as from mean high tide seaward three miles along the Washington coast from Cape Flattery south to Cape Disappointment.
The statute enumerates eight criteria to be met or exceeded in the decision-making processes by which the state of Washington and local governments must develop plans for the management, conservation, use, or development of natural resources in Washington's coastal waters (RCW 43.143.030).

The Seashore Conservation Act – (RCW 43.51.650-685)
Enacted in 1967 and substantially amended in 1969, the Seashore Conservation Act (SCA) declares the necessity of dedicating the uses of the Pacific Ocean Beaches of Washington "…to public recreation and to provide certain recreational and sanitary facilities." The SCA also established "for the recreational use and enjoyment of the public" the Washington State Seashore Conservation Area and placed its administration under the jurisdiction of Washington State Parks and Recreation Commission. The SCA applies to "the beaches bounding the Pacific Ocean from the Straits of Juan de Fuca to Cape Disappointment at the mouth of the Columbia River.

The Shoreline Management Act of 1971 – (RCW 90.58) (WAC 173-145)
The citizens of Washington State passed the Shoreline Management Act (SMA) in 1971 in recognition of the state's shorelines as "among the most valuable and fragile of its natural resources" and the great concern throughout the state relating to their utilization, protection, restoration, and preservation. The SMA includes all shorelines (streams greater than 20 cfs and associated wetlands

and lakes larger than 20 acres) and shorelands (lands extending 200 feet from the Ordinary High Water Mark of the shoreline). The goals of the SMA are to:

1. Plan for and foster all reasonable and appropriate uses of the shorelines;
2. insure development of shorelines in a manner which, while allowing for limited reduction of rights of the public in the navigable waters, will promote and enhance the public interest;
3. protect against adverse effects to the public health, the land and its vegetation and wildlife, and the waters of the state and their aquatic life.

The SMA calls for cooperative program between local governments and the Department of Ecology. It provides local governments with special guidelines for creating their policies and regulations for shorelines of statewide significance. Regulation must minimize human-made intrusions on the shoreline

Ecology protects and manages the water of the state through implementation of the SMA.

Uniform Building Code
The Uniform Building Code (UBC) is a voluntary code made available to jurisdictions by the society of engineers and building officials that live and work in that region. The International Conference of Building Officials (ICBO) is the organization that promulgates the UBC. It is not automatically the code of the state uses to regulate construction. See State Building Code above. The State Building Code is based on the UBC but has significant modifications to suit the needs and specific practices of Washington builders.

Washington State Comprehensive Emergency Management Plan (CEMP) 1996
The CEMP is a comprehensive framework for statewide mitigation, preparedness, response, and recovery activities, and provides for interoperability between local, state and federal levels of government during emergencies or disasters.

Washington State Flood Damage Reduction Plan, July 1995
The plan serves as a vehicle for coordination between state, local and federal jurisdictions as they work toward identifying risk and reducing vulnerability to flood damage. The plan identifies statewide flood damage reduction goals and objectives.

Washington State Wind Mitigation Report and Action Plan, May 1994
The basic purpose of this document is to make recommendations to strengthen the state's wind mitigation efforts as a result of damage from the inauguration day wind storm that occurred on January 20, 1993.

Washington Wildfire Mitigation Plan 1994
The purpose of the plan is to address issues relating to the prevention and mitigation of damage from interface wildfire while maintaining a strong awareness of all wildfire prevention.

Water Resources Development Act – (Public Law 104-303)
Addresses the national dam safety program. Managed by the Department of Ecology.

APPENDIX E – DESCRIPTION OF CURRENT EVENTS

Appendix "E" describes recent Washington State disasters earmarked by presidential declarations. With the single exception of the Mount St. Helens volcanic eruption, none of the following events predates 1990. The Washington State Hazard Identification Vulnerability Analysis (2000) has a more complete history of Washington Disasters.

May 18, 1980 (DR-623-WA)

On May 21, 1980, the President of the United State declared all of Washington State a disaster area because of the May 18, 1990 volcanic eruption of Mount St. Helens. This event was characterized by an explosive volcanic eruption, catastrophic debris avalanche, flooding and volcanic ashfall that affected the entire state.

On March 24, 1980, information was first received by telephone from the U.S. Geological Survey (USGS), Denver, that there had been extensive seismic activity on Mount St. Helens. Notification of seismic tremors increasing in number and magnitude and the possibility of a volcanic eruption came at 3:10 PST, March 25, 1980.

On May 18, 1980, Mount St. Helens erupted violently. At 8:32 Pacific Standard Time, a magnitude 5.1 earthquake occurred about a mile beneath the volcano, triggering a catastrophic series of events that transformed Mount St. Helens picturesque mountain landscape into a gray wasteland.

The earthquake shook the walls of the volcano's summit crater and triggered many small rock avalanches. Within seconds, a huge slab of the north flank of the volcano began to slide, and small dark clouds billowed out of the base of the slide. Plumes of steam and ash also rose from the crater of the volcano. As the avalanche of rock and ice raced down the north flank of the mountain at more than 155 miles per hour, a massive explosion blasted out the north side of the volcano. This lateral blast became a fearsome hurricane of ash and rock that outpaced the avalanche. Probably no more than 20 to 30 seconds had elapsed since the triggering earthquake.

An Avalanche of rock, ash, ice, water, and fallen trees flowed as far as 15 miles down the valley of the North Fork Toutle River. Debris dumped into Spirit Lake raised the lakebed by more than 295 feet. Seventy percent of the glaciers that had crowned the volcano were gone – melted by the heat of the eruption or carried away by the fast-moving avalanche. Towering forests with trees up to 150 feet were flattened and strewn like matchsticks in the wake of the lateral blast and debris-laden avalanche (U.S. Department of the Interior, 1998).

Ashfall was a serious problem on May 18, and a lesser problem on the subsequent eruptions of May 25, June 12, July 22, August 7 and October 16. Ash created serous traffic, breathing and cleanup problems.

The eruption displaced an estimated four billion cubic yards of material on land and into the atmosphere. Much of this material was deposited in the North and South Forks of the of the Toutle River, and some of it moved down the Toutle and deposited an estimated 50 million cubic yards in the Lower Cowlitz and 55 million cubic yards in the Columbia River. The Toutle and Cowlitz Rivers were nearly filled with sediment and debris, thereby reducing the hydraulic capacity and creating a threat of major flooding. The Cowlitz River at Castle Rock lost 85% of its channel capacity and shoaling in the Columbia River initially closed the river to all commercial navigation. In addition, the ash plume caused extensive ash removal and damage in Eastern Washington, Northern Idaho, and parts of Montana.

The initial eruption may have killed as many as sixty persons with 35 confirmed dead and 25 missing and presumed dead.

The initial flooding, which accompanied the mudflow, destroyed or damaged 221 homes; at least 12 bridges; caused extensive road and utilities damage; and destroyed a water treatment plant, four water intakes, and three sewer outfalls (Federal Emergency Management Agency [FEMA] Region X, 1981).

Washington State Commerce and Economic Development estimated the total short-term loss to the economy of Washington State from eruptions in May and June at $959 million. The largest losses occurred in the forest damage – almost $450 million, and in cleanup costs - $363 million. About $106 million in property was destroyed or damaged. Agricultural losses, primarily from hay destruction, may exceed $39 million. Income losses totaled almost $9 million. Port and airport losses are approximately $2 million (Washington State Emergency Management Division [EMD] & Federal Emergency Management Agency [FEMA] Region X, 1980). In the sixteen months following the eruption, about $400 million was spent by various federal agencies for their disaster-related activities in Washington State.

October 16-24, 1991 (DR-922-WA)

During the period of October 16-24, 1991, Ferry, Lincoln, Pend Oreille, Spokane, Stevens, and Whitman Counties in Washington State incurred substantial fire and wind damage. President Bush declared these counties a disaster area on November 13, 1991.

Because of the declaration, federal funds were made available to state and local governments and the private sector for emergency work and restoration.

Several factors combined to create nearly unavoidable circumstances for this fire event. The spring of 1991 was unusually wet and generated abundant vegetative fuels. During the summer and early fall there was typical warm temperatures and little precipitation. By mid-October, no measurable rain had fallen for over a month and a half. In addition, the fire season ended in September, which meant all the regular summer fire crews had been dispersed.

The storm on October 16 was not a typical autumn squall. It was more characteristic of a spring storm. A low-pressure weather system from Canada and high-pressure ridge from Oregon and Northern California collided over Eastern Washington. The pressure differential between the two fronts, called the gradient zone, produced extreme wind patterns.

By 8:30 a.m., winds were gusting up to 50 knots and sustained winds averaged 35 and 40 knots for nearly 8 hours. Record-breaking gusts of 62 mph were registered at the Spokane International Airport, and higher in the surrounding areas, before the winds began to die out in the afternoon around 4:00 or 5:00 p.m.

A second similar storm was predicted for Monday, October 21. Fortunately, it did not create the havoc and damage the first storm did.

Multiple sources of sparks and arching electrical connections touched off the Spokane area fires. The fires spread rapidly and overwhelmed suppression efforts in a few hours. The task of fighting nearly 100 sizable interface fires, which started in one 24-hour period, challenged resources and skills beyond reasonable limits.

Trees blown over by high winds downed power lines. The downed lines apparently touched off some of the fires. In some cases, dust and smoke may have caused flashover between electric conductors, possibly causing pole-top fires. Furthermore, dust obscured visibility making it impossible to see the smoke emanating from the initial fires until the fire grew in size or reached homes, barns, or businesses.

According to the National Weather Service in Spokane, the storm was not of the type to generate lightning. No lightning touchdowns were detected in monitoring equipment.

There was one fatality. Ninety-two fires burned approximately 35,000 acres, destroyed 114 homes, and 250-300 other buildings. Damages exceeded two million dollars in natural resources, and cost more than $12 million to control. Nearly 400 personnel were committed to the fires.

The fires moved extremely fast. It became apparent, as in past fires, that most of the damaged or destroyed structures were not constructed with fire-resistant roofing or materials. Vegetation and materials surrounding and up to the structures had not been cleared. There was no adequate two-way ingress/egress route and there was an inadequate water supply, or existing water supplies had no backup power systems (State of Washington Department of Community Development & Department of Natural Resources, 1992).

January 20, 1993 (DR-981-WA)

On the morning of January 20, 1993, hurricane force winds swept through central Western Washington. The windstorm caused great destruction, many injuries, and the loss of five lives. On March 4, 1993, President Clinton declared King, Lewis, Mason, Pierce, Snohomish, Thurston, and Wahkiakum Counties a disaster area.

A powerful low-pressure system moved into Washington State from the Pacific Ocean with winds averaging 50 miles per hours and gusts of up to 100 miles per hour. Falling trees knocked out power to over 750,000 people. For some, the power was out for over eight days. Falling trees and flying debris blocked many roads, and damage homes, businesses, and public facilities. The damage and debris restricted access to the affected areas hindering relief efforts. The windstorm caused five deaths and numerous injuries.

Trees falling on buildings, power and telephone lines, and roads caused most of the damage from this storm. Falling trees and limbs damaged hundreds of homes. Fires ignited by fallen power-lines also damaged several buildings. Some major public structures suffered more than superficial damage. For example, both the floating bridges across Lake Washington, I-90, and SR-520, sustained damage to the pontoons that keep the bridges afloat.

The loss of electrical power imposed serious hardships on many families, public agencies, and private organizations. Hardships included no heat, light, or cooking capability, and lack of water, waste disposal, and operational communications systems. Debris from damaged and downed trees littered roads, parks, public places, and private property. Some critical facilities, services, and private agencies had no backup power.

Emergency response forces from all state, local, and private agencies were stretched to the limit. Mutual aid support came from as far away as California, Oregon, and British Columbia, Canada. Disaster related costs eligible under the federal public facility repair and restoration program exceeded $27 million (Washington State Department of Community, Trade & Economic Development, (1994).

November 7-December 18, 1995 (DR-1079-WA)

On January 3, 1996, President Clinton declared Washington eligible for disaster assistance for the period of November 7, 1995 through December 18, 1995. The declaration affected 16 counties in Western Washington and three in Central Washington.

Starting November 7, 1995, unusually heavy and prolonged rainstorms began causing floods in

several western and central Washington counties. In addition, unseasonably warm temperatures melted the snow pack at higher elevations. These conditions continued unabated and by December 2, 1995, most of the rivers in Western Washington were at or above flood level. These rivers include the Cowlitz, Nisqually, Puyallup, Cedar, Snoqualmie, Skokomish, Stillaguamish, Skykomish, Skagit, Nooksack, Wenatchee, Klickitat and Yakima, and other lesser rivers and creeks. The flooding resulted from a combination of saturated ground, high river levels, heavy rain, high freezing levels and melting snow.

On December 12, a major windstorm that affected the entire west coast, causing winds that approached velocities seen only once in the last three decades, followed the flooding. The incident period for these events lasted from November 7, 1995 through and including December 18, 1995.

The Governor declared a State of Emergency on November 28, 1995. On January 3, 1996, the president declared a federal disaster for nine counties, eight of which were in Western Washington and one in Central Washington. Declared Western Washington counties include Cowlitz, Grays Harbor, King, Lewis, Skagit, Snohomish, Thurston, and Wahkiakum. Chelan County is in Eastern Washington. Clallam, Clark, Island, Jefferson, Kittitas, Mason, Pacific, and Whatcom Counties were added to the declaration on 11 January. Yakima County was added for Individual Assistance only. Pierce County was added on January 17, bringing the total number of counties to 19.

According to the Seattle District, Corps of Engineers report "Flooding in Pacific Northwest from Late November to Early December 1995," the estimated return frequency of the flood peaks on average were in the 10-20 year range, compared to flooding in the 20-30 year range in the larger flood disaster of 1990 in Western Washington. A 30-year event was seen on the upper Skagit: this was the largest flood of the four events that have caused damage in this area in the last 17 years. However, flooding on the lower Skagit, in the Mt. Vernon area, was of a lesser frequency (a 12-year event) than in 1990 when a 40-year event was experienced.

On average, estimated return frequencies of flood peaks tended to be in the 20-year range for rivers south to the Cedar River, and approximately 10-years and less for rivers further south to the Chehalis River. However, notable exceptions were the Cowlitz, which experienced a flood approaching the 100-year frequency, the Cispus, and the Stehekin, Wenatchee and Icicle Creek in Chelan County, all of which experienced flooding with frequencies in the 100-year range. Undocumented estimates of three-day volume flows on the upper three forks of the Snoqualmie River had return periods beyond the 50-year frequency, which helps account for the extent of the inundated floodplain and media reports of damages and rescues (EMD & FEMA Region X [DR-1079-WA], 1996).

January 26-February 10, 1996 (DR-1100-WA)

A warming trend caused many rivers across Washington to flood between January 26, 1996 and February 23, 1996. On February 9, 1996, President Clinton signed a disaster declaration that eventually included 23 counties and the Yakima Indian Nation. There were two deaths and ten injuries.

Due to the flash floods in eastern counties of the state, this event was considerably more extensive in severity than DR-1079-WA. The U.S. Army Corps of Engineers and the U.S. Geological Survey estimated this event generally in the 10-25 year range. Specific exceptions included the Green River, which was between a 75-100 year range; the Yakima, Chehalis and Nisqually Rivers, at 100-year, and the Puyallup River, which was a 150-year event (EMD & FEMA Region X [DR-1100-WA], 1996).

November 19 to December 4, 1996 (DR-1152-WA)

DR-1152-WA covered an incident period from November 19 to December 4, 1996. A wind and ice storm characterized this disaster. Governor Lowry proclaimed a state disaster on November 20, 1996, and President Clinton declared a federal disaster on January 7, 1997. The president's declaration included public assistance and hazard mitigation aid for Spokane, Pend Oreille, and Klickitat Counties due to ice, freezing rain, and heavy snow damage.

Heavy rain began falling on November 18 on top of previous early heavy snowfall. At Spokane International Airport freezing rain began at 8:25 a.m. on November 19, 1996, and continued throughout the day until 5:36 p.m. The period of heaviest freezing rain was between 2:00 p.m. and 4:00 p.m. when .29 inches fell. This freezing rain event was one of the heaviest in the city began keeping records in 1887. The event was limited to a relatively small area. The majority of the impact from the ice storm was to an area of approximately 1500 square miles. Heavy snow fell 20 miles to the north of Spokane, while rain fell, with above freezing temperatures, immediately south of the area. Temperatures remained below freezing. Icing conditions and snow persisted until November 27.

In other areas, snowfall from this storm system was extremely heavy at times, ranging from 6 to 35 inches in a matter of hours. Conditions were similar in Pend Oreille and Klickitat Counties. Yakima County had a record 18.9 inches of snowfall in a 24-hour period on November 18-19, 1996.

Loss of power was one of the main problems occurring from the November 19, 1996 ice storm. The combination of freezing temperatures and the weight of ice broke many tree limbs, a significant number of which fell onto power lines, damaging them and disrupting service. Spokane County experienced widespread power outages when 11 of 12 major power distribution lines went out of service, many broken by the weight of the ice encrusted on the lines. In many instances up to 3 inches of glaze covered the trees, snapping limbs onto power lines. More than 100,000 Washington Water Power (WWP) customers had no power, many for several weeks. Many residents in the Newman Lake area of Spokane County, for example, were without power for over nine weeks. Pend Oreille County had power outages for up to 20 days. Klickitat County was without power for at least five days. Power outages affected a variety of critical facilities, including the Spokane International Airport, which was closed for over two days. The power disruption affected lighting and heating, as well as pumping stations for water and sewer systems. Fire protection systems were also affected.

In addition to fallen trees affecting power lines, tree branches littered roads and other public and private facilities, effectively halting travel in many areas. In the City of Spokane, extensive damage was done to park and landscaping trees, critically damaging the City's "urban forest.

Three deaths occurred, although only one occurred in a declared county. The first two deaths were in Yakima County. The first occurred when a tree fell on a camper during high winds and the second was caused by heavy snow collapsing an occupied carport. The third death occurred in Spokane County when a utility worker was electrocuted during the repair of a natural gas leak (EMD & FEMA Region X, 1997).

December 26, 1996 to February 10, 1997(DR-1159-WA)

DR-1159-WA was proclaimed a state disaster by the governor on December 29, 1996, and declared a federal disaster by the president on January 17, 1997. Landslides, excessive snow loads, ice, wind, and riverine, stream, and groundwater flooding characterized this event.

The aid covered 38 of 39 counties of the state for Individual Assistance, Public Assistance, and Hazard Mitigation. Wahkiakum County declined participation in the declaration, however, it was proclaimed by the governor and was eligible for U.S. Department of Transportation Emergency Relief for federal highways.

As of February 12, 1997, estimated storm damage to public facilities exceeded $160 million (collapsed roofs, road repairs, and debris removal on public property). According to State Insurance Commissioner Deborah Senn, insured losses from the 1996-97 winter storms were estimated at $140 million, with over 75,000 claims expected. This level is exceeded only by the January 1993 Inaugural Day Windstorm, which totaled nearly $190 million in insured losses. These estimates do not include uninsured damages, damages to public facilities, or most damages from landslides.

Western Washington was struck by two major winter storms within four days. The storms, which were the result of a strong confluence of the northern and southern branches of the jet stream, which brought cold, dry air together with warm, moist air resulting in large amounts of snow and freezing rain. A third, significantly warmer storm followed that rapidly melted the accumulations of snow and ice in the lower elevations. The force of this storm series brought devastating effects from landslides, flooding, snow, ice, wind, and groundwater flooding.

The morning after Christmas 1996, snow began falling in south King County at 6:00 a.m., and north King County at 8:30 a.m. The first storm lasted from December 26 to late on the 27th, leaving up to 20 inches of snow in the lower elevations of Western Washington. In addition to the snow, freezing rain left an accumulation of thick ice or glazing in areas to the south and east of Seattle. Clark County, in the southwest corner of the state, reported up to 5 inches of ice in some areas. Sea-Tac Airport, which had the largest freezing-rain event of its record, experienced delays and cancellations of flights related not only to the weather, but also to the lack of de-icing fluid and extreme congestion during peak periods of holiday travel. Electrical power was disrupted to over 250,000 customers due to fallen trees and branches breaking the power lines. Many significant cross-state highways, including those through the Cascade Mountains and the Columbia River Gorge, experienced prolonged closure due to avalanches.

The second storm began at 8:30 p.m. on December 28 and continued throughout the next day, dropping as much as two feet of snow on the lower elevation of Western Washington. At 5:00 a.m. on 29 December, the snow turned into rain, which saturated the accumulation of snow. The weight of the rain-soaked snow caused extensive structural damage to marinas, building roofs, and carports. The rain, along with the rapidly melting snow, also resulted in widespread flooding, contributed to sink holes, landslides, and again halted cross-state highway travel.

Because the initial temperatures between December 26th and 29th remained near or below freezing, runoff from the storms did not occur at a constant rate. Instead, the precipitation remained in the snow pack until it was rapidly melted by the combination of warmer temperatures and heavy rain. Many southwest Washington rivers began flooding on 29 December due to this exceptional runoff rate. The Chehalis River reached its eighth highest crest in the last 32 years, overrunning I-5 and forcing evacuation of several homes and businesses. Other rivers reaching significant crests were the Naselle, Skookumchuck, Willapa, Skokomish, and Deschutes.

Just as many of the communities were finally able to handle the impacts of the unusual winter weather, yet another storm pelted Western Washington on December 31 with high winds and locally heavy rains lasting until January 1, 1997. These conditions, combined with the ongoing rapid snowmelt, resulted in flooding

over a number of Western Washington rivers, as well as many landslides. Relatively minor flooding occurred in most of the rivers south of the Snohomish River Basin, as well as some to the east of the Cascades. Along the coast, the combination of high tides, 25-foot swells and heavy runoff caused additional flooding in those areas.

Dramatic fluctuations in temperature and precipitation levels for Seattle tell part of the story. The coolest day (27 degrees) was on December 29. The warmest winter day (56 degrees) was December 31. The rainiest day (1.92 in.) was on December 29, and the snowiest days (24 in.) occurred between December 26-29.

Snow and rain from December 26, to January 1, dumped nearly 5.4 inches of water on western Snohomish County. Temperatures in Hoquiam rose from 35 degrees to 50 degrees in just one hour on December 29.

The same storm systems that pounded Western Washington during December and January affected the eastern side of the state, but in quite a different manner. Eastern Washington had experienced a generally cold and snowy period until the last week of December, when warmer temperatures and moist air moved into the region. Many areas experienced between one and two inches of rain over a two-to-three day period, which melted snow accumulations and led to flood conditions in parts of Eastern Washington.

On New Year's Day, many small streams and creeks (including Rock Creek in Spokane County, upper Latah Creek in Spokane and Whitman Counties, Pine Creek in Whitman County, Asotin and George Creeks in Asotin County, and Pataha Creek in Garfield County) flooded a number of structures and closed several roads. A few larger rivers also exceeded flood stage including the South Fork of the Palouse River in Pullman and the Snake River east of Asotin.

River flooding was minor but widespread, with only 16 rivers exceeding flood stage. Damages, however, were anything but minor because of the riverine and urban flooding. The Touchet River, Asotin Creek, and Pine Creek all caused significant damage in February 1996, as well as in January 1997.

Damage occurred throughout the state from a complex series of winter storms, with repeated cycles of freezing rain, snow, strong winds, and rapidly rising temperatures with warm rains. These weather conditions led to widespread power outages due to fallen trees, multiple collapsed structures from the crushing weight of ice and snow, flooding from streams and rivers, blocked storm-drain systems and high groundwater tables with localized groundwater flooding, and the erosion of roads and hillsides with the subsequent loss of utilities and damage to homes. These effects were exacerbated in many areas due to the earlier flood disaster of November 1995 and February 1996.

Interstate 90 was closed at Snoqualmie Pass due to avalanches stranding hundreds of travelers. The Monorail closed between downtown Seattle and the Seattle Center because of damage from ice on the external cables. The Tacoma Narrows Bridge was closed for approximately 2.5 hours because of falling icicles. Many homes and businesses were evacuated due to the threat of landslides. Over 500,000 electric power customers were without power, light, and heat. Some households were without power continuously for more than two weeks and many experienced repeated outages. The road closures affected commerce and tourism during the holiday ski season.

There were 27 deaths attributed to the 1996-97 winter storms (see Table 2). Three occurred during the November-December 1996 storm (DR-1152-WA) and 24 lives were lost during the December 1996-February 1997 winter storms (DR-1159-WA). No deaths occurred during the March or April 1997 events (EMD & FEMA Region X, 1997).

Jurisdiction	#	Date	Cause
Yakima County	1	1996	Snow-loading-collapsed carport
Yakima County	1	1996	Tree fell on carport
Spokane County	1	1996	Electrocution
Island County	1	1/02/97	Traffic accident
King County	1	12/27/96	Asphyxiation
	1	12/29/96	Tree fell
	1	12/31/96	Tree fell on car
City of Seattle	1	12/27/96	Fell from roof
Kitsap County	1	12/29/96	Collapsed carport
	4	1/19/97	Landslide - house into bay
Mason County	1	12/28/96	Tree fell
Pierce County	1	12/30/96	Traffic accident
Skagit County	1	12/26/96	Traffic accident
Snohomish County	1	12/27/96	Heart attack
	1	12/28/96	Heart attack
	2	12/29/96	Heart attack
	1	12/29/96	Respiratory failure
	1	12/29/96	Traffic accident
	3	12/27/96-12/29/96	Avalanche-snow hikers/campers
	1	12/31/96	Heart attack
Walla Walla Co.	1	12/30/96	Traffic accident

Table - 2. Winter Storm Deaths, Nov. 1996-Feb. 1997

March 18-28, 1997 (DR-1172-WA)

DR-1172-WA was proclaimed a state disaster by Governor Gary Locke on March 19, 1997 and declared a federal disaster by the President on April 2, 1997. Riverine flooding, ground water flooding, and landslides characterized this disaster. Thirteen counties were affected. Individual Assistance was made available in Clallam, Grays Harbor, King, Kitsap, Lincoln, Mason, Pacific, Pend Oreille, Snohomish, Spokane, Stevens, and Thurston Counties. Public Assistance was available in Grays Harbor, Jefferson, King, Kitsap, Lincoln, Mason, Pacific, Pend Oreille, Snohomish, Spokane, Stevens, and Thurston.

Heavy rainfall over Western Washington on March 18 and 19, 1997 caused record flooding on some rivers. Precipitation for March ranged from 190 percent of normal over the western Cascade foothills to 230 percent of normal over the Olympic Peninsula.

The heaviest rain occurred over the Olympic Peninsula and coastal Southwest Washington, where rainfall totals for the event ranged from an average 6-12 inches to over 20 inches. Approximately 2-4 inches of rain fell over the west slopes of the central and north Washington Cascades.

This event was remarkable in several respects. During a " Pineapple Express, " the southerly branch of the jet stream typically extends from near Hawaii to the Pacific Northwest, tapping into the supply of subtropical moisture. In this event, the southerly branch originated near 15 degrees north (about five degrees latitude south of Hawaii), producing extraordinary rainfall. This is a highly unusual pattern even for winter, but for mid-March it is truly exceptional.

The rainfall produced record crests on several rivers of coastal Southwest Washington and the Olympic Peninsula, including the Naselle, Satsop, and Skokomish Rivers. The Wynoochee River on the south slopes of the Olympic Peninsula, which has a flood control dam on it, flooded for the first time since 1968. The rivers flowing off the western slope of the Cascades rarely experience serious flooding after February. However, significant flooding occurred along several of these rivers. The Snoqualmie River near Carnation, for example, crested at 58.57 ft. (flood stage is 54 ft. and major flooding begins at 58 ft.). Previously, the highest crest on

the Snoqualmie near Carnation after the month of February was 55,84 feet, which occurred on March 6, 1972.

The flooding on the Satsop and Wynoochee Rivers in Grays Harbor County had the greatest impact. Both rivers exceeded 100-year flood discharges by a considerable amount. The Corps of Engineers preliminarily measured the discharge on the Wynoochee at 25,600 cfs; the 100-year discharge from the Grays Harbor County Flood Insurance Study is 23,000 cfs. That would place the March 1997 flood at around a 200-year event. Likewise, the Satsop River experienced a discharge of around 62,500-cfs. The 100-year discharge from the Flood Insurance Study is 52,300, making the March 1997 flood at least a 200-year flood. Around 200 families were evacuated out of the valleys of the two rivers, some by helicopter. These rivers flooded and damaged many homes, farms, and roads. US Highway 12 (the primary east-west route between Olympia and Aberdeen/Hoquiam) was flooded and damaged in several locations. Some farm animals were killed along these two rivers. It flooded homes that were entirely outside the designated flood hazard area, particularly seven homes located in the Wynoochee Tracts Subdivision.

The Skokomish River in Mason County experienced flood heights that exceeded the record stage of November 1990. However, the peak was much shorter than in 1990, and it is uncertain whether or not the March 1997 discharge exceeded the discharge of 1990. About two dozen families were evacuated from the flood plain. The river flooded US Highway 101 and damaged the Highway 101 bridge over the Skokomish River. Flooding also damaged State Route (SR) 106 and other roads, numerous farms, and the Skokomish Tribal Center. Landslides in this area also contributed to the damage.

The Naselle River reached a record crest, flooding about a dozen homes in this sparsely populated river valley. According to the Corps of Engineers, the preliminary peak discharge of 12,400 cfs made this approximately a 100-year flooding event. It also flooded numerous farms and roads, including SR 4. The Snoqualmie River caused extensive flooding in the Snoqualmie River Valley. It flooded farms and caused about a dozen road closures. However, there were no reports of homes or farm buildings being flooded.

In addition, minor to moderate flooding occurred along the upper Cowlitz, Willapa, Chehalis, Elway, Dungeness, Cedar, Skykomish, Snohomish, Stillaquamish, Skagit, and Nooksack Rivers.

Heavy rainfall also drenched Eastern Washington. According to the National Weather Service in Spokane, the heaviest rainfall within their service area was recorded in Northeast Washington and in the northern portion of the Idaho Panhandle. At the time, temperatures were very mild with many areas reporting temperatures from 5-15 degrees above normal.

Several rivers and streams flooded during this period. Among these the most significant were the Little Spokane, Colville, and Pend Oreille Rivers as well as Latah Creek. As an example, the little Spokane River crested at an estimated 8.24 feet on March 21, 1997. The previous highest recorded stage of the river was 7.29 feet at Dartford in Spokane County on February 17, 1970. The river had breached the 1970 record on March 19 and crested on March 21, 1997. Nearly a dozen homes were flooded near Dartford, and the nearby Pine Creek Park was almost completely inundated. Water covered portions of Golden Road, Meadowbrook Road, and little Spokane Drive. Flooding and a few bridge washouts were also reported along the tributaries of Dragoon, Deep, and Deadman Creeks.

In western Spokane County, especially near Medical and Clear Lakes, homes were threatened and several flooded. Flooding also created problems along Chester Creek and Newman

Lake. Urban flooding was reported in the city of Spokane, predominately in the area of 57th and Freya Streets.

In Pend Oreille County, landslides blocked portions of Highway 20 north of Cusick, and floodwater from Pend Oreille River closed LeClerc Road north of Usk. One house was damaged by slippage near Lone. Forty homes received varying degrees of flood-related damage in the Diamond Lake area.

In Stevens County, the Colville River flooded lowlands and pastures lying along the river. There were several closures of secondary roads in the southern part of the county due to high water.

Landslides occurred in several counties, especially in Western Washington causing many homes to slide or to be hit by slides. The combination of pre-existing saturated soils, extremely heavy rain, and winter storms caused lateral movement of groundwater that triggered numerous slides and made existing slides in the steep bluffs and ravines that border Puget Sound, Lake Washington and the larger river valleys worse.

Areas that had experience slides in earlier events experienced additional failure in this disaster, particularly in Seattle, on Whidbey Island and in Snohomish County. Other areas, such as portions of Vashon Island in King County, and Gorst Creek refuse fill in Kitsap County, experienced damage for the first time. The city of Seattle had about a dozen new landslide sites, with a total estimated damage of $6.3 million, compared to over $20 million in DR-1159-WA.

Access to some communities, such as Brooklyn in Pacific County, was cut off due to debris accumulation on roads of flooding or roadways caused by debris accumulation in culverts. There was a severe first time landslide on the west side of Harstene Island in Mason County causing considerable damage to one residence and minor damage to another. Fifteen hundred feet from the two houses, there was subsidence and cracks in the land warning that this area may be a future landslide hazard. For the first time, Grays Harbor County experienced several severe landslides causing closure of East Satsop Road and West Satsop Road. Copalis Beach Road was also closed due to landslides. Some communities, such as Metaline Falls in Pend Oreille County, suffered from damaged utilities and power lines. The city did not have power or potable water for almost a day.

Flooding on the east side of the Cascades was typical for a rain on snow and/or spring snowmelt event. In the City of Sprague, Negro Creek flooded portions of the city that had not experienced flooding since 1976. Negro Creek caused shallow flooding throughout the City of Sprague, but did not cause major damage. On the west side of the Cascades flooding was not normally expected this close to spring.

In Clallam County, the Dungeness River caused major damage in two areas. At one site approximately two miles upstream from Highway 101, the river migrated and eroded the ground under a house, leaving it hanging over the river. At the lower end of the river along Rivers End Road, homes were flooded because a levee on the right bank is higher than the land on the left bank, allowing floodwaters to inundate the left side of the river along Rivers End Road. There were numerous smaller streams throughout the declared counties in Eastern and Western Washington that experienced flooding mostly in the range of a 2-10 year frequency, causing mostly minor damage, but also some localized significant damages.

The record precipitation levels from the previous two winters when combined with this event resulted in expanded damage in previously flooded areas, and new sites being flooded by groundwater. Spokane and Thurston County had the most significant areas of groundwater flooding. However, nearly all of the declared counties experienced some groundwater flooding. Areas

in Spokane County experienced basement and lake flooding. Thurston and Pierce Counties experienced new groundwater flooding sites that were not present earlier in the year with DR-1159-WA. Thurston County had nearly 1000 acres subject to groundwater flooding. Pierce County had a new lake form in an industrial park. The lake was nearly two miles long and a quarter of a mile wide. Losses due to seepage were a problem, and were witnessed in several of the disaster counties (EMD & FEMA Region X, 1997).

April 10-June 30, 1997 (DR-1182-WA)

DR-1182-WA, affecting Pend Oreille County, covered an incident period from April 10-June 30, 1997. Governor Locke proclaimed a state disaster on May 22, 1997. Federal assistance was requested on July 11, 1997 and President Clinton declared a federal disaster on July 21, 1997. The county was eligible for Individual Assistance and the Hazard Mitigation Grant Programs. No deaths were officially attributed to this event.

Unusual weather conditions began on May 22, 1997. The snow pack in the upper elevations of the Pend Oreille River drainage in Montana and Idaho was 150 percent of normal, creating a situation which led to extreme flooding conditions when high temperatures and warm rains occurred.

During the week of April 10, 1997, the heavy snow pack in the Montana Mountains began melting, which caused 23 million-acre feet of water to inundate the Clark-Fork/Pend Oreille drainage river basin. With the previous ground saturation, water and rain combined to create river elevations 8 feet over flood stage and more than 17 feet above normal. According to the National Weather Service, flooding of this magnitude had not been experienced in the area in the last 25 years.

Of the 230 dwellings sustaining flood damage, 83 homes, businesses, public utilities, and public facilities where destroyed and/or rendered uninhabitable. Many residences had 3-to-6 feet of standing water for several weeks causing extensive structural and foundation damage. Many families were dislocated for nearly three months. Flooded septic and potable water systems led to health advisories. Roads and bridges were affected, restricting travel in this rural and remote county. Agricultural fields were under water for six weeks of prime growing season. Power and other utilities were disrupted for some time.

The county, with information obtained through the National Weather Service, the Natural Resource Conservation Service, the U.S. Army Corps of Engineers, and the Department of Ecology was able to organize community meetings to clarify roles and provide warnings, as well as promote flood insurance. An emergency dike was constructed around the town of Cusick through efforts of the county and the U.S. Army Corps of Engineers which saved the town and the entire Kalispel Valley, although the Kalispel Indian ceremonial tribal culture center and three river resorts were damaged. The economic impact to this area, which had the highest unemployment rate (19.6 percent), was a concern.

In early May, flooding problems also were occurring on the Spokane River in Spokane County; the Naches River in Yakima County; and the Okanogan, Methow, and Similkameen Rivers in Okanogan County.

May 26-29, 1998 (DR-1252-WA)

Governor Locke declared a State of Emergency on May 29, 1998 and President Clinton declared a major disaster in Ferry and Stevens County on October 5, 1998. Extensive flooding on May 26 and 27, 1998 characterized this event.

Over 2.8 inches of rain fell in less than 24 hours, following 10 days of rain that had amounted to over 3.3 inches. The National Weather Service Office in Spokane reported that this rainfall equaled or exceeded a 100-year event.

Ferry County was the most significantly impacted area. Damage to the Ferry County road system was devastating, totaling $1.8 million. Thirty-five percent of the roads within the county were damaged and were not accessible or had limited/emergency egress. The flooding took out gigantic quantities of roadbed material carving waterways through roads and through private property. Traffic had to be routed with detours of twenty miles or more on rural county roads. As a result or rerouting traffic in the county, roads that were not damaged by the event had increased traffic, which caused significant deterioration. State Highway 20 was closed for three months.

The county fairgrounds sustained $1.4 million in damage. Sediment up to two feet in depth was deposited throughout 75 percent of the fairgrounds. The fairgrounds are a major source of income for the county and local commercial enterprises. Total damages in Ferry County were approximately $3.2 million.

April 23, 1998 - Present (DR-1255-WA)

On April 23, 1998 the City of Kelso issued its first letter of "Imminent Danger" to a resident and subsequently issued a Proclamation of Emergency on May 19, 1998. Governor Locke signed a State of Emergency proclamation on June 11, 1998 and requested assistance from the President on June 17, 1998. President Clinton declared the affected Aldercrest area in Kelso, Washington a disaster area on October 16, 1998.

The Aldercrest-Banyon failure is an unusually large (3,000,000 yds^3), deep-seated translational landslide. The landslide was caused by rejuvenation of an ancient deep-seated slide whose 75-foot-high headscarp is located directly west of homes bordering the west side of Banyon Drive. This headscarp is covered by thick soil and trees, which are more than 100 years old. Rejuvenation almost certainly occurred because of three consecutive years of annual-precipitation records in the Kelso area (Lingley, William S. Letter to Martin Best, 28 May 1998).

A subsequent geological report indicates that two slides are active in the Aldercrest subdivision, the main Aldercrest-Banyon slide and another slide off the north slope of the hill facing the Coweeman River. That slide is on steep undeveloped ground, but immediately borders houses along the northwest and north margins of Banyon Drive. The north slope slide is shallower than the mammoth slide that rips through the middle of the 73-acre subdivision. It includes small zones of surface debris avalanches and deeper slow-moving displacement that has distorted buildings and titled some trees, according to a January 27, 1999 GeoEngineers Inc. report.

The landslide (currently active at the date of this publication) caused extensive damage to homes, public utilities, public facilities, and infrastructure in the City of Kelso. One hundred thirty-seven homes are at risk. All losses to date, both private and public are uninsured.

APPENDIX F – MITIGATION SURVEY REPORTS

Note: This page of Appendix "F" is intentionally blank. When a presidential disaster is declared, mitigation survey reports will be filed here in sequential order. Each report will act as an update (required following each presidential disaster) to the *Washington State Hazard Mitigation Strategy*.

Direct comments concerning this publication to:

Washington Military Department
Emergency Management Division
Attn: Hazard Mitigation Strategist
Camp Murray, WA 98430-5122
Phone 253.512.7072
E-mail mailto:(j.vollmer@emd.wa.gov)